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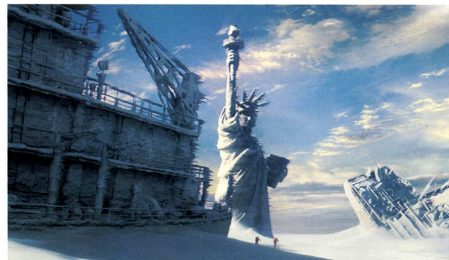
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Brave New World

ARTICLE BY JOE FORDHAM

Sherman Oaks, California, 1995. Aluminum foil covers the sliding doors of a one-bedroom apartment. Inside, a frame of PVC pipes stands before the light-masked window, supporting a 15-foot bluescreen surrounded by C-stands and movie lights. Above, on a balcony overlooking the room, film school graduate Kerry Conran oversees proceedings at his Power PC Macintosh home computer, while his friend and former film school tutor, Eric Adkins, operates a Sony Mini-DV camera, shooting actors that parade by the bluescreen in period costumes. The production is an early test for an experimental film played against digitally generated backgrounds — an experiment that, nine years later, would yield Paramount Pictures' fantasy extravaganza, *Sky Captain and the World of Tomorrow*.

The journey from living room to 3,000 theater screens began at California Institute of the Arts, where Conran enrolled as a film major in 1986. "Cal Arts' film school was divided into three categories," Conran recalled. "They had live-action, animation and experimental animation. I was enrolled in the live-action program, but I crossed the line and spent most of my time with the animators. They were doing a lot of conventional animation, and were also using the first color Macintosh and Cubicomp's PictureMaker to do experimental work. It was rudimentary stuff, but it fascinated me. I didn't fancy myself as an animator, and I was always interested in live-action; but I liked what they were doing, and I started to try to fuse those two worlds."

Conran's student work included a film that featured hand-drawn animation blended with live-action using rotoscoping and aerial image projection. "I wanted to combine live-action and animation in the way that *Bedknobs and Broomsticks*, *Pete's Dragon*, and *Mister Limpet* had," explained Conran. "There weren't too many examples of that back then. I wanted to integrate animated characters so that they could interact with real objects, immersing them in a live-action world." Conran and Eric Adkins worked on the project for a year and a half, then heard rumors of an upcoming studio release, *Who Framed Roger Rabbit*. "It was devastating, because it was very similar to what I was trying to do, using live-action rigs to lift props, then painting over the rigs; but they did it on a scale beyond anything I could have imagined — so I never finished my film."

After graduation, haunted by his incomplete student project, Conran continued to entertain notions of applying traditional animation to a live-action film. "I started looking at old movies," Conran commented, "deconstructing frames, examining what comprised the image. I wondered how a filmmaker might create those images two-dimensionally, treating live actors as a 'cel' by shooting them against bluescreen to extract them from the background — then, just like animation, applying them to a completely new environment."

Brave New World

ARTICLE BY JOE FORDHAM



Conran's dreams were kick-started in 1993 by the release of 'Egg' — code name for software developed by the Company of Science and Art, a group of Brown University computer science graduates who conceived a consumer-level compositing product, released commercially as After Effects. "I didn't understand it at first," Conran admitted, "but when it hit me, it was staggering. I suddenly realized that I could take live-action components, break them up as if they were 2D elements, and marry them together using the computer. Of course, that's quite conventional by today's standards; but predating *The Phantom Menace* and *The Matrix* and *The Lord of the Rings*, it wasn't as intuitive or as obvious. It was quite experimental."

Experimentation led to tests in Conran's apartment and the development of a potential storyline. Conran's story — a fanciful science fiction yarn cast in the mold of Republic movie serials — was set in New York 1939, and involved reporter Polly Perkins enlisting the help of old flame Captain Joe Sullivan, an intrepid fighter pilot, to unravel the mystery of a spate of disappearing scientists and a giant robot invasion. While honing his story, Conran also developed visuals with his brother Kevin, who had recently graduated from a graphic arts school in Michigan. "Kevin and I toyed around with conceptual ideas," Conran recalled. "We did 3D development in Maya, with compositing mostly in Adobe After Effects. Originally, the film was almost entirely motion graphic in design. We ended up using Apple's Shake, splitting the difference at times; but we started out in After Effects, and it worked well for us."

The initial presentation — a six-minute reel depicting performers woven into period settings, menaced by skyscraper-high robots — featured photographic backgrounds obtained from stock imagery and 3D robots animated by Conran from footage of himself performing a lumbering mechanical walk on a treadmill. Conran gave the film a vintage black-and-white look, complete with simulated dirt and scratches, and, after four years' work, presented a VHS of the reel and a foot-tall robot maquette to producers Jon Avnet and Marsha Oglesby, who agreed to develop the script with him.

Conran spent the next two years writing eight drafts of the screenplay. Then, with the completed script in hand, Avnet approached Jude Law to play the leading role of *Sky Captain*, and went to Gwyneth Paltrow for the role of Polly Perkins. When both actors expressed interest, Avnet secured financing for the film from producer Aurelio De Laurentiis. "There was no way a movie studio was going to give Kerry the kind of freedom I believed he needed to make this kind of movie," Avnet explained. "Aurelio came aboard with the notion that I would sell the domestic rights after we finished principal photography, and he would sell the foreign rights. The movie would sell itself. I did this specifically so that Kerry would not have the typical interference of a studio during principal photography."



Jude Law stars as a Daredevil fighter pilot in *Sky Captain and the World of Tomorrow* – an imaginative melting pot of Republic serials, art deco design and film noir – written and directed by first-time filmmaker Kerry Conran. After graduating from the California Institute of the Arts, Conran assembled a six-minute presentation reel for the film with production designer Kevin Conran and director of photography Eric Adkins. Nine years later, artists at World of Tomorrow, in Van Nuys, and more than a dozen visual effects subcontractors brought the vision to the screen – blending bluescreen performers into worlds constructed from digital models and photographic and archival material.



The Hindenburg III appears through a snowstorm in the skies above New York City, 1939 – opening the film and immediately setting the retro-futuristic, art deco mood. WOT modeled the dirigible digitally, referencing documentary photographs of the 1937 Hindenburg, with custom detailing per story requirements, which called for the airship to moor with a docking tower at the top of The Empire State Building. Snow falling through the scene heightened the stylized effect of the zeppelin slicing through the clouds. WOT generated snow with particle systems rendered and composited in layers, creating a magical cel-animation-style multiplane effect.



Gigantic walking robots menace the citizens of New York City. Persons fleeing in the distance were created as motion-capture-animated characters, while midground and foreground figures were extras shot against bluescreen at Elstree Studios in England. To help build New York City environments, WOT visual effects supervisor Darin Hollings joined Eric Adkins on a one-week digital photo safari, gathering static photographic textures of period urban architecture. WOT modelers then referenced the textures to develop a 3D model representing a four-block area of the city. Animators positioned additional buildings as they choreographed shots.



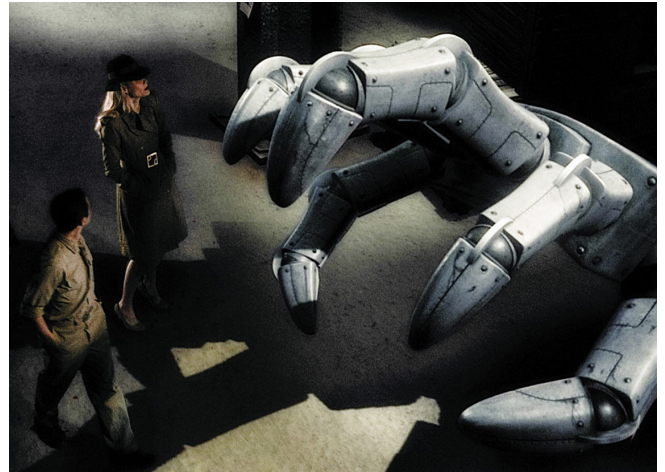
The marauding robots focus their attack on power generators beneath the city streets. WOT created exploding buildings and erupting asphalt using Maya rigid body dynamics. The walking robot was one of the earliest 3D models realized for the film, its rounded shapes and mechanical parts inspired by the artwork of Alex Raymond and Hugh Ferriss. Limited articulation reflected the robots' primitive nature as the first in an increasingly sophisticated Evolutionary chain of mechanical marauders seen through the film. WOT keyframe-animated all robot action for the sequence.

Production ramped up in 2002 with the renting of production space in Van Nuys and the hiring of key effects personnel. the *World of Tomorrow* production company's first major hire was visual effects supervisor Darin Hollings, who signed on after a garage screening of Conran's original reel. "It was clearly out of the ordinary realm of visual effects," Hollings commented. "It had such a compelling, different look — very graphic, very stylized and very nice to look at. Halfway through the reel, I started thinking that if they were going to make this movie, there was no way I was not going to be involved. I didn't tell them that! I knew that they had contacted some other visual effects supervisors, who had said it was impossible for the allocated budget. They were looking for people who were willing to take a bit of a risk."

The unusual nature of the project called for an unorthodox conceptual approach. "Kerry's script had characters trekking mountains in Nepal," said Hollings, "and an incredible flying aircraft carrier in the sky — which, on face value, might seem to be \$60,000 to \$80,000 shots. With every shot in the movie a visual effect, a traditional bid might have ended up with a \$50 million effects budget — more than our budget for the entire movie. But, looking closer at Kerry's short, I saw that every background was an archival photograph with pretty simple composites and not a lot of CG — shots that might go together in a day. I became very optimistic, because I realized the style was so forgiving. This wasn't a glossy, photorealistic look. We had shots with hundreds of robots, but they were basically the same robots in every shot, so we could amortize elements. Early on, we were also planning to do a completely black-and-white film, which made it exponentially simpler because we didn't have to deal with 10-bit log and 16-bit linear images, lining up different color spaces. This was 8-bit black-and-white! It really did seem like a brave new world of visual effects."

Hollings recruited former associates from Disney's effects facility, The Secret Lab, to occupy other key roles and address the feasibility of translating Conran's experimental techniques to a feature format. "We first approached this movie very much the way Kerry had approached his six-minute short," noted 2D supervisor Stephen Lawes. "We were mostly using photographic backgrounds with bluescreen footage and some CG elements. Almost immediately, we found that it was more efficient to generate backgrounds for the animatics in 3D, so we switched our approach. It helped give us a better sense of timing and motion."

Armed with Conran's script, reel and laptops, modeling supervisor Zack Petroc and team began concentrating on the New York-set opening scenes, while Conran developed storyboards and a four-person animation team kept pace. "Some of the animators had not worked professionally before," recalled animation director Steven Yamamoto, "so we tackled the movie sequence by sequence and,



Fighter pilot Joe Sullivan (Jude Law) and newspaper reporter Polly Perkins (Gwyneth Paltrow) examine a fallen robotgiant within the confines of FlyingLegion headquarters. Kerry Conran directed Law and Paltrow in minimal bluescreen sets, shot over a hectic six-week period onElstree soundstages. Principal photography was the third stage in a four-part production – 2D storyboards progressing to 3Danimatics, which guided the live-action shoot, finishing with 3Danimation and composites.

before each sequence, held a two-part class — one on animation and one on filmmaking. I recreated a course I had taken at film school about camera movement, explaining what we wanted from each sequence, dramatically and visually, showing references of different movies. I then explained how scenes should build and where the story points should occur.”

Production structured a pipeline for creating shots, dividing the story into five chapters. After developing storyboards for the first chapter, the team would start producing 3D animatics for that chapter while simultaneously storyboarding chapter two. “After we went through the film with storyboards and animatics,” Hollings said, “we shot the entire movie in Van Nuys using photo doubles, before we went to shoot the real actors in London. The idea was that we would refine the story at each stage.”

Early visual development included the gathering of static photographic backgrounds for the opening of the film. “Eric Adkins and I took a stack of storyboards and a Nikon D1X and spent a week in New York City,” related Hollings. “We got up at 6 a.m., and shot until the sun went down every day.” Locations included façades on Franklin Street in Tribeca, alleys and rooftops around Wall Street, and the interior of Radio City Music Hall. “Because we had an animatic for Polly’s entry into Radio City, and knew that the camera was roughly three feet off the ground, we were able to shoot nodal tiles that we stitched together later. When we were shooting with Gwyneth, we set the camera at the same height and it lined up.”

Alignments between live-action and virtual cameras required careful calibration during tests of photo doubles in the Van Nuys shoot. “One of the issues we ran into,” observed Eric Adkins, who served as the film’s director of photography, “was that whereas motion picture film cameras measure distances from objects to the focal plane, high-def cameras come from an electronic news-gathering background where distances are traditionally measured from the end of the lens. ‘Cine Style’ versions of these cameras are designed to bring focus measurements back to the focal plane, using lenses that react more like motion picture lenses, where the rotation increments are stretched out and marked to make it easier for a follow-focus person to hit the marks. As we started shooting, we found that although virtual sets and actors lined up pretty accurately at 15 feet and over, two-shots or closeups 10 feet and closer just weren’t lining up.” Adkins and Hollings determined that the misalignment was specific to the length of the Cine Style zoom lens. “Every lens we tested had a different offset measurement. I chose the Fujinon 5-50mm zoom because it was easier to previsualize the offset, rather than recalculate for a series of prime lenses on the shooting stage. We had about a ten-and-a-quarter-inch offset, which happened to be the measurement from the chip to the end of the lens. So we moved the camera back ten and a quarter



Robots renew their attack on New-York with a fleet of sinister,flapping flying machines. WOTmodeled and keyframe-animatedthe machines and generatedcloudscapes using digital clouds combined with 360-degree imagetiles, assembled from digitalphotographs taken from the roof of the WOT production building. Aerial views of the city featured background plates photographedfrom a helicopter in New York by Eric Adkins and Darin Hollings.Ground-level shots featured WOT location images, archival material from an online image library and extensive digitally animated environments.

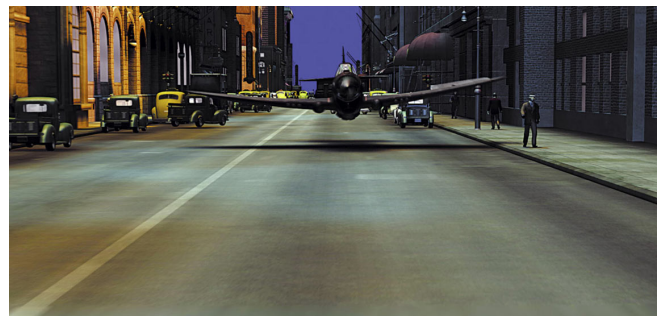
inches, and treated the end of the lens as our focal plane — or ‘nodal’ point — and everything clicked into place.”

Calibration of the Sony CineAlta F900 high-definition video cameras with the Maya cameras allowed Hollings to develop a system to map the location of all the filmmaking ingredients — lighting, cameras, props and actors. “We created a map of the sets in the animatic,” stated Hollings. “We stood actors on their marks, derived from these maps — Polly on G-11, Sky Captain on H-12, the camera on B-1, three feet in the air at 20 degrees with a 35mm lens. We then mixed between the live-action and the animatic on a video switcher to check the lineup.”

After several months of shooting in Van Nuys, the filmmakers developed a virtual map of the film that could be translated to the shooting location. The production selected Elstree Studios in England for principal photography. The studio’s George Lucas Building soundstage housed the main bluescreen sets, with ancillary stages used for smaller setups — all of which Conran’s team first explored in the virtual realm. “We constructed a virtual Elstree in the computer,” explained Conran, “then built our set inside the virtual studio and rotated it to fit. We positioned cameras to the animatic, and then simply translated those coordinates to our Elstree grid; so when we set the camera in a certain place and panned it, we knew exactly what we’d see.”

The six-week shooting schedule — with three weeks of simultaneous second-unit shooting — required a new camera setup every twelve and a half minutes. “For the first two weeks, I was up almost all night,” said Hollings, “because we were shooting 14-hour days and had no time to prep for the next day. In Van Nuys, we had shot everything on one stage. In England, we had what was, at one point, the largest stage in London, with three huge bluescreen setups, multiple cameras, plus second unit stages.” With animatics trickling in from California, Hollings and tracking supervisor Candida Nunez prepared printouts of each setup using bluescreen set data obtained from theodolite surveys taken by Plowman Craven & Associates.

On stage, most sets were conveyed with bluescreen props and select interactive objects. “If actors touched an object,” Conran explained, “we either used a blue object that we later replaced, or we used a practical prop. If Gwyneth picked up a coffee cup in her hand, we used a real coffee cup. But when Gwyneth was typing behind her desk in her newspaper office, we had no desk. There was only a typewriter and a blue box. Everything else was digital. The typewriter was real because she interacted directly with it.” Kevin Conran designed all of



the sets and props, which Zack Petroc and team translated into 3D. Construction crews built key points of contact — such as doors — per the director's specifications. "We handled doors in two ways. Some were just blue, partly because we couldn't afford to build them as intricately as we could in the computer. Other doors were real."

Minimal sets facilitated speedy redresses, allowing Hollings and Adkins to work a tag-team with three cameras — positioning A/B camera setups, then running to another stage to prepare the third camera. Omnipresent bluescreens and a symmetrical lighting plot allowed Conran to quickly stage reverse angles by rotating actors rather than the camera. "We had the same lights on the left and right of camera," said Adkins, "so, for a quick reverse, we could turn the actors around, fade up and dim down lights to simulate the reverse direction, and we were ready to go."

The strategy averaged 25 first-unit setups a day, with crew and performers constantly referencing the animatic plan. "All I could do was provide the actors with the context as best I could for what was going to happen," noted Kerry Conran. "By reviewing animatics, we could remind ourselves of what was going on; but when we walked out on to that stage, there was nothing there and it was very quiet. That was challenging on our most dramatic shots, and I could only marvel at the actors. Jude was so utterly convincing. I remember watching him in the cockpit of his fighter plane with just a bluescreen behind him. I glanced at the monitor, and I was convinced that he was flying. He was so committed. The actors just embraced it."

Visual influences in the cinematography included the romantic Hollywood style of James Wong Howe and the dark slicing shadows of film noir, adapted for bluescreen. "We used no in-camera diffusion," said Adkins. "We added that in post. We had a lot of low, back and sidelights, which produced very bright highlights, especially in high-def, so I shot the whole film with a polarizing filter to tone down the glare. In film noir, environments are essentially created by shadows. We obviously could not do that — shooting bluescreen, we didn't have an environment to create the shadows — so we created lighting effects using pools of light, gobo cutters or blue columns to block the light on set."

The photographic style had been derived from the months of testing in Van Nuys, during which time crews settled lighting and grain issues. "We determined early on how much grain we wanted," said Stephen Lawes. "Kerry decided to ditch the animated scratches and dust used on his short film, because after six minutes it became distracting." Early tests with photo doubles in L.A. and backgrounds in Radio City Music Hall also molded decisions in contrast, diffusion and — most importantly — color. "The movie was originally going to be completely black-and-white, except for the sequence where the characters arrive in Shangri-La, which was going to be in color to punctuate



While combating the robot flying machines, Sky Captain and his P-40 fighter plane narrowly avoid a head-on collision with an automobile. WOT blocked out animation using color 3D models to establish timings, and dressed streets with marquees, vehicular traffic and animated pedestrians. Compositors broke the image into color and black-and-white layers, added 2D deep background detail, texture mapping and the P-40 propeller. Bluescreen footage of a foreground driver and virtual automobile interior vignettted the shot. A layer of diffusion brought the composite together, emulating 1940s-style cinematography, with subtle hints of color restored in the final composite.

the effect — a nice ‘ta-daah!’” In consideration of commercial viability, the all black-and-white notion was tossed. “We still wanted to retain a film noir feel, so we spent some months investigating how to treat the color to create a unique period effect.” With outside vendors, the production investigated colorization that would simulate the look of hand-tinted black-and-white film; but color choices proved subjective. “We had all the color information in our HD photography, so we decided to find a way of using it ourselves, automating the task to create our own stylized look.”

The color treatment process divided imagery between two compositing departments — black-and-white and color — and layered composites in a technique reminiscent of a centuries-old fine art process. “It was akin to oil painting,” related Lawes. “The black-and-white was an underlay. We then applied washes of color over that at very low percentages to create rich depths of color. Black-and-white compositing took us 65 to 70 percent there, establishing contrast, diffusion and composition. Color compositing then added color layers, sandwiching the color of CG or photographic backgrounds with colors from the bluescreen shoot.”

The first glimpse of color in the movie occurs as a zeppelin passenger peers from a gondola window at a snow-covered New York City below, flesh tones pinpointing the character in the largely monochromatic image. “We tried to introduce as much color as we could into the opening sequence,” noted color compositing supervisor Miae Kim, “but when it snows in real life, the environment takes on a black-and-white quality, so that was the look we went for. *Black-and-white* set the contrast and focused the eye on one spot in frame. We then enhanced that with color.”

The leviathan dirigible — the Hindenburg III — looms over New York City, setting the art-deco mood. “Kevin Conran felt that zeppelins spoke more to the genre than any other airship,” stated Zack Petroc. “We used a lot of historical reference and textures from photographs of the 1937 Hindenburg to model our airships, but we also scaled details, like the railings, as we needed for specific shots and as Kerry needed for his narrative.”

To generate the city seen in dizzying views beneath the zeppelin, WOT employed digital background plates shot from a helicopter in New York by Eric Adkins and Darin Hollings. Ground-level views combined WOT location images with those obtained from the Corbis online image library. However, as animatics evolved after the London shoot, it became clear that 3D would play a significantly larger role than planned. “We realized our pipeline was not going to be able to handle rendering New York,” stated Hollings, “so we bolstered our shot construction systems with a more substantial lighting pipeline.” Hollings recruited director of technology Brian Chacon, CG lighting director



The P-40 roars over panicked commuters, pursued by flappingwing attackers. WOT fashioned landmarks such as The Empire State Building and the Chrysler Building as positionable models, which artists could place and adjust to compose backgrounds. Period automobiles were sampled from stock digital models or, in many cases, created and detailed from scratch. A digital referencing system allowed modelers to place and scale set dressing and street-level detail. Digital artists lit the models with lighting rigs designed to provide dramatic emphasis, positioning lights to focus on key story points and create a sense of speed and tension.

Michael Sean Foley and CG supervisor David Santiago to lead the new initiative. “David wrote the scripts to build a RenderMan pipeline allowing animators to dial up pieces of CG models by hitting a couple of buttons. They could do their animation, save it as a Maya embedded language script, which the lighters could then grab to light and render. Michael Sean then oversaw the artistic side of all the 3D CG lighting.”

Lighting designs were based on a number of classic movie references. “Kerry wanted the coloring effect to resemble the Technicolor look of *Black Narcissus*,” said Foley. “He talked about a sequence that had the feel of the original *King Kong* and *She*. Another sequence featured a laboratory set reminiscent of *Frankenstein*. I was sold!” In their first three weeks on the project, Foley and Santiago funneled 11 terabytes of existing WOT imagery into the new RenderMan pipeline.

To quicken the pace of production, WOT staff, technical resources and space were all expanded at the project’s one-year mark. “We were working as fast as possible to create a chunk of the movie, so we could sell it,” Hollings related. In June 2003, Avnet presented potential studio distributors with a 24-minute presentation reel of color finals, *Black-and-white* comps, live-action with animatic backgrounds and raw bluescreen footage. When bidding concluded, Paramount emerged as the domestic distributor, and a June 2004 release date was set.

Though Paramount eventually moved the release date to September, its original June 1 delivery date remained essentially unchanged; and, with the clock ticking, Hollings and Avnet were forced to reexamine both the production pipeline and the initial goal of completing 2,000 CG shots in one year, all in-house. “It was an incredibly ambitious goal,” Avnet observed. “By September 2003, it became clear that it was not an achievable one. At that point, I made the decision to begin outsourcing segments of the film.” WOT would still deliver an impressive 1,100 shots within a 14-month time period.

Joining the production during the transition period, senior visual effects supervisor Scott Anderson — a veteran of large facility-based effects projects and independent freelance assignments — and co-producer Brooke Breton divided approximately 900 shots between additional visual effects vendors, all chosen, in part, for their enthusiasm for the project. “This was a true independent filmmaking experience,” said Anderson. “The project was independently funded, sold as a negative pickup, and was made by a group of people who were passionate about it, who shared in the idea of coming together to get this done. We may not have had a lot of money, but the people we brought onboard responded to the material and wanted to help us make it work — they all got it. That was the critical part of this project. The technical aspects were supporting a creative endeavor.”



Flying Legion headquarters comes under robot attack, with menacing tendril robots crashing into a laboratory and abducting one of Sky Captain’s associates. Physical effects supervisor Trevor Wood provided practical effects for the Elstree bluescreen shoot, including falling debris and girders for the wall-smash scene. WOT generated tendril robots digitally, modeling and animating the creatures as sinister successors of the giant stomping robots. Wire rigs supporting human performers suggested practical interactions between robots and their victims, as did shadows and reflections composited onto the robot’s metal body.

Anderson analyzed shot counts, elements and style to determine methods to meet the remaining shot quota, while maintaining artistic consistency, and focused on a primary post-shoot challenge — the modeling of New York. Initiated by a team of three modelers, which grew to only six over the entire two-year production, the main New York City model spanned four blocks and served as the arena for a giant robot attack. “The scope of New York City was vast,” related Zack Petroc. “We fleshed out the city in a low-rez form for the animatics. Then, as we focused on specific shots, we used medium-rez buildings for larger blocks, adding detail shot by shot. We built separate models of landmarks such as The Empire State Building and the Chrysler Building, and we also built ‘template blocks’ with different nomenclature for sizes and types of buildings. We could pull buildings up or down 30 feet to recompose a shot, or switch water towers and pigeon coops.” Modelers used a referencing system to place and scale signage, billboards, awnings, chairs, shoeshine stations and minutiae of street-level detail. “I knew the team had lost it when I stopped by a workstation one day and saw one of our team modeling a strip of mustard on a hotdog at a hotdog cart. It was time to move on at that point!”



On the trail of the robot attackers, Sky Captain and Polly land in Nepal and are greeted by a Sherpa guide. Kerry Conran shotperformers against bluescreen, with Jude Law crouched on the wing of the film’s largest prop – a partial reconstruction of a Curtiss P-40 Warhawk, consisting of the cockpit and a portion of the wing. The remainder of the fighterplane, the Himalayan scenery and the Sherpa base camp were regenerated digitally. WOT modeled the P-40. CafeFX then assembled, textured and lit the shot, adding background mountains using aDigital Backlot matte painting.



Sky Captain and team trek across an icy Nepalese plateau, following clues to a forbidden valley, believed to be

the source of a radio transmission directing robot attacks. Actors tramped through practical fake snow during the bluescreen shoot to help create interactions with the terrain, particularly in closeups. For wider shots, compositors created footprints by tracking and revealing trails of impressions beneath the performers' feet. CafeFX modeled the snowscape using digital matte paintings by Digital Backlot.

Modelers used photographic stills of One Bunker Hill in Los Angeles to create a digital tile of the Chronicle newspaper building exterior and lobby. With the exception of the Chronicle logo over the desk, the lobby was generated in 2D. For a brief scene in which Polly Perkins pauses to speak with her editor, Mr. Paley (Michael Gambon), in the newspaper office — shot as a pickup in London — production used its only entirely practical set of the film. “We had so many shots to finish,” said Conran, “we built that practically for speed and time.”

Prominently featured in the New York sequence are six 90-foot-tall robots, seen tramping down Sixth Avenue, laying waste to city blocks with death rays accompanied by vintage sound effects obtained from Paramount’s 1953 *The War of the Worlds*. The walking robots were among the first CG models designed and constructed for the film. Five additional robotic characters are revealed during the course of the film, implying an increasingly complex *Evolutionary* chain as the story unravels the mystery of their origin. “We wanted to give the robots a sense of coming from the same birthplace,” Zack Petroc related. “We developed a sensibility to the surfaces of the models, but it was more of an aesthetic than a procedural pipeline. We based the development of the form — rounded shapes and working mechanical parts — on Kevin Conran’s drawings, verbal direction and many references, including the art of Alex Raymond and Hugh Ferriss.”

The walking robots were entirely keyframe animated, unlike their presentation reel predecessors. “We ended up not using any roto-animation,” noted Steven Yamamoto. “We only used motion capture for tiny people in the backgrounds, and keyframed everything else. We animated each of our robot designs to move a little differently. The first ones couldn’t even turn their heads. We then had flying robots with flapping wings, more sophisticated robots with mechanical tendrils, underwater crab robots, hover-pack robots and sentry robots.” Despite the numbers of robots seen in attacks throughout the film, the production did not employ any procedural animation systems beyond relatively standard particle animation. “Near the end of the movie, where we had hundreds of rocket-powered hover-robots, we did some simple particle instancing and replacement. We didn’t have crowd simulation software, like Massive, and we only had three animators; so we never really had the time or resources to develop anything like that.” Effects animation lead Chris Williams used Maya rigid body dynamics for destruction scenes — shots of buildings falling down, billboards exploding and bombs detonating. Darin Hollings also shot two days’ worth of explosion elements with pyrotechnician Richard Helmer, and generated nine gigabytes of pyro motion clips, which compositors used throughout the film.

The New York sequence also put WOT’s revamped lighting and rendering pipeline to the test. “We approached each sequence like lighting a practical movie set,” said Michael Sean Foley. “We lit wide shots first, then pushed in and composed for closeups. We set up a single lighting rig for each

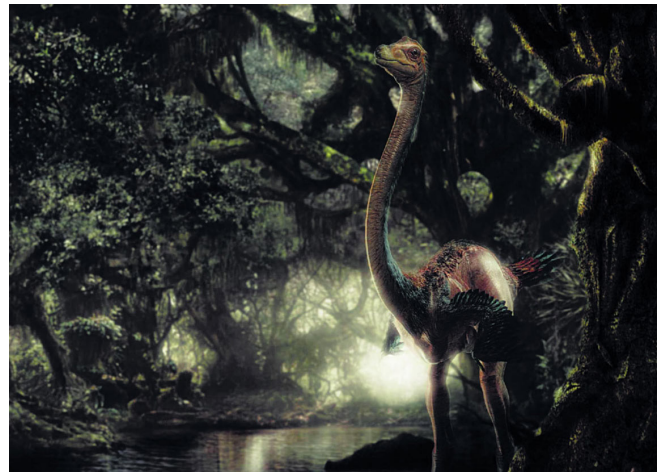
sequence, from which the lighter could choreograph all of the shots, then rendered a frame for each camera, ironing out the ‘clinkers’ until we had a reference frame for each shot.” The approach allowed a single artist to light and render smaller-scale interior sequences at a rate of 20 to 60 shots per week. For action sequences covering broader geographical distances — including the chase through New York — Foley designed lighting rigs based on time of day and key-to-fill ratios, with close attention to dramatic emphasis. “I designed a map of the chase and positioned lights to focus story points, creating a sense of speed and tension. We then handed out those lighting maps to our lighters — all five of them! They lit the first 100 shots in one week.”

In response to the giant robot attack, *Sky Captain* makes a dramatic entry in his Curtiss P-40 Warhawk fighter plane — the largest physical set piece created for the film. The replica consisted of the cockpit and part of a wing, built from stock aircraft pieces with a few gadgetry additions. “We would have loved to have had a full airplane,” said Hollings, “but that didn’t fall within our budget; so we built only as much as we had to, then modeled the rest in CG.” Testing in Van Nuys helped define the choices for simulating flight with camera movement and propeller motion. Physical effects supervisor Trevor Wood’s team constructed a low-tech gimbal rig beneath the cockpit and created banking moves by manipulating the rig manually. “It was not hydraulic,” said Wood, “it was what we called ‘hand-draulic.’ It was all done by hand, with a very simple ball-and-socket construction, which worked fine because we didn’t have to match any previous movements. We also built a rollover rig so we could spin the plane 360 degrees, with Jude and Gwyneth inside.”

The P-40 — seen in closeup throughout the film — required extensive detailing and remodeling to accommodate science fiction gadgets that sprout from the craft’s fuselage. “We tried to keep it as close as possible to the profile of a real P-40,” Petroc noted. “We threw in a passenger seat for Polly, which we based on a trainer version of the aircraft, and we sometimes extended the cockpit to allow Kerry better camera angles.” Sky plates featured digitally generated clouds and 360-degree digital image tiles of skies photographed from the roof of the production building in Van Nuys.

Sky Captain is first summoned by a radio signal that radiates from a giant beacon on a stylized planet earth. “We deliberately made the topology of the continents look slightly off,” stated Petroc. “Kerry and Kevin wanted the globe to look like it might have been handcrafted for the old serials of the time — as if it was a plaster ball, rather than a digital model.”

Conran and crew had developed the faux-miniature style during the early research period, when they had looked into the possibility of using miniature elements for some sequences. “The notion



In time, Sky Captain’s quest leads him to a tropical realm, whose stylized appearance was based loosely on Skull Island from the original King Kong. During the bluescreen shoot, the jungle consisted of strategically placed potted plants, used in shots of actors moving through vegetation. SW Digital created digital flora, then mixed bluescreen actors with 2D and 3D elements. SWD also developed and animated fanciful jungle denizens employing WOT maquettes and a 1940s movie creature aesthetic – extrapolating little-known biological specimens to monstrous dimensions.

wasn't to make a completely CG movie," stated Conran, "it was just to make this movie, with any techniques available. We thought some sequences might be more easily achieved — or, frankly, more fun to look at — if we used miniatures. We ended up not going that route; but we attempted to light our CG models to look like physical models. One of the characteristics associated with photographing miniatures is that they are often lit with such large lights that they don't have the correct atmospheric falloff. We tried to mimic that in CG."

The New York aerial assault, full of swooping shots darting through skyscraper canyons, grew during postproduction to approximately 300 shots as animators connected the dots between live-action plates. A creative logjam during development of the latter part of the sequence was solved by the arrival of lead animator Rob Dressel. "Kerry was stumped on a story point," Steven Yamamoto recalled, "and I had a brain freeze. We showed Rob the beginning and the end of the scene, and let him loose. About three days later, he showed us a brilliant piece of animation that bridged the gap by having *Sky Captain* fly through the legs of the robots, then drop a magnetic bomb that attached to one robot's foot. That was not written or storyboarded — it was from Rob's imagination."

The robot air attack also devastates *Sky Captain's Flying Legion* headquarters — a sprawl of hangars and runways surrounded by mountains that incorporated scenic textures shot at Van Nuys Airport and entirely synthetic structures. Zack Petroc's team made use of SensAble Technologies' Freeform software for organic modeling and SensAble's Phantom Desktop haptic device — an armature-like user interface — to sculpt and manipulate virtual objects with sensory feedback. Artists modeled and projected trees onto 2D cards to dress the terrain.

During the attack, *Sky Captain's* engineer, Dex (Giovanni Ribisi), is snatched from the *Flying Legion* control room by two tendril robots that crash in through a wall. Trevor Wood's team provided falling debris and girders. Conran shot the interaction between live and CG elements, with Ribisi supported by a wire rig. WOT rotoscoped Ribisi and added shadows and reflections in the metal of the robot's body.

The mission to rescue Dex and determine the identity of the mysterious attacker took the tale through strange worlds and inventions, and involved the talents of more than a dozen additional visual effects vendors — averaging 100 shots apiece — all of which used WOT animatics, models and lighting designs. Vendors funneled full-color images through WOT, which generated color-corrected 'look frames,' taking building blocks of shots and applying an atmospheric patina. "The most important thing was limiting the color palette," related Stephen Lawes. "We wanted just enough separation to create a sense of volume and depth. It was not completely monochromatic, duo-tonal or even quad-tonal. After we made sure the elements were integrated correctly into the scene, we always pushed the diffusion and the contrast to give the shots a much more glamorous feel. It was all about the design and beauty of the image."

Sky Captain's journey to the screen was a long haul. But the project was a unique opportunity for effects artists to collaborate with filmmakers and to exert greater creative control. "Movies like this do not come along very often," stated Darin Hollings. "It was not only a very different story that looked different and used different techniques, it was a whole new approach. It was extremely challenging and amazingly collaborative — and Jon Avnet deserves a lot of credit for that. He was courageous in taking on the production to begin with; and he knew that Kerry and Kevin were the heart and soul of the project, so he protected them and allowed them to make the movie they wanted to make."

Avnet and Aurelio Di Laurentiis are leaving options open for a sequel to their film, depending on audience response; but, whatever the future brings for *Sky Captain* and *the World of Tomorrow*, at the end of production *World of Tomorrow* will close its doors.

"We were never an effects facility," observed Kerry Conran. "We were a production company, simply making a movie, and I regarded all the staff at WOT as part of that filmmaking crew. Our approach may have been unconventional, but it was simply a means to an end, a way to use effects that are typically reserved for studios with \$150 million budgets and bring them into the independent realm. Rather than pushing for photorealism, we embraced the digital medium and had fun with it. I would like to do it again, to dream up something even bigger. Digital filmmaking is only bound by imagination. I don't think we've scratched the surface yet."

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A fleet of British Royal Navy flying fortresses emerges from clouds, providing *Sky Captain* and Polly with safe haven during their wild adventure. A four-person team at WOT modeled the aerial aircraft carrier. Pixel Liberation Front artists then collaborated with Pacific Title Digital to supply visual effects for the sequences featuring the immense craft. PLF developed WOT animatics, texture-mapped the environment and added 3D detail to closeup sections. Pacific Title assembled production composites, making use of WOT cloud material and generating combat explosions using combinations of WOT pyro elements and particle effects.

Bronze Age Ballistics

image

ARTICLE BY JOE FORDHAM

The impact of Ridley Scott's 2000 Oscar-winning *Gladiator* inspired a renaissance of period dramas in Hollywood and sent ripples around London's Soho media district, the community from which it sprang. "The talent pool has grown enormously in the last few years," observed visual effects supervisor Nick Davis, who lately chaperoned two *Harry Potter* films in London. "I think we have proved we can handle bigger pictures and that we have the means to deal with this type of work."

Leading one of the biggest pictures to come to London's shores, director Wolfgang Petersen — veteran of effects-heavy pictures from *Das Boot* to *The Perfect Storm* — met with Davis in 2002 to discuss conjuring the majesty of Ancient Greece for Warner Brothers' *Troy*. "Wolfgang's main gambit was photoreality," Davis recalled. "Troy, to him, was an epic movie that had to look completely real. We had to create Troy, huge battle scenes and a massive armada of Greek ships in hard-key daylight, without it looking like CG. Wolfgang wanted a blend between *Lawrence of Arabia* and *Black Hawk Down*. It was Homer's *Iliad*, with epic internal beats; but it was also a pretty violent story, so it had to be gritty and real."

Screenwriter David Benioff based his screenplay on Homer's ancient poem, which recounted 51 days in the final year of the 11-year siege of Ilium — Troy — by the massed forces of Ancient Greece in 1193 B.C. Benioff's adaptation ejected the mythological elements of gods manipulating fates of mortal champions, and expanded the human backstory. The Trojan king's son, Paris (Orlando Bloom), absconds with Helen (Diane Kruger), wife of Spartan chieftain Menelaus (Brendan Gleeson), and inspires the Greeks to muster a fighting force, including Odysseus (Sean Bean) and Achilles (Brad Pitt), to set sail for Troy, seeking retribution.

Based at Shepperton Studios in England, the production employed artists on three continents to realize the epic, including a 3D animatic previsualization team from The Moving Picture Company, which mapped battle plans in Maya. To ground designs in photographic reality, the production chose to re-create 3,000-year-old cities on location in Malta. "We took a lot of geographical reference from Aegean locations — the real locations of Mycenae, Sparta and Thessaly — and used those textures to help drive our digital matte paintings," stated Davis. "Our canvas started with Malta, and we built out from there."

While Davis developed visual effects, physical effects supervisor Joss Williams and makeup effects supervisor Daniel Parker re-teamed from a previous association on HBO's *World War II* miniseries *A Band of Brothers* to make preparations at Shepperton. "We drew upon our experience with the logistics of filming large numbers of people in battle sequences," commented Williams. "I also drew from 16 weeks of preparation I had done for HBO's *Alexander the Great*, which ended up not going into production. That had given me a lot of experience with spear hits, swords and arrows."

Early research explored practical arrow hits on actors in dynamic action scenes. "We developed arrow hits that performers could fire for themselves," explained Williams. "They sprung out of the

costume — propelled by high-pressure air — so quickly, the eye could not detect that they were springing out rather than going in. They were based on the theory of a magician's wand: the shaft is floppy and segmented, with a bit of rope running through, and when you pull the rope, it stiffens. We made arrow shafts out of segmented pieces of black nylon, with rubber flights, and had a cable running through to an air-operated switch. The air cylinder was a length of high-pressure hose that went inside the costume with the floppy arrow. When the performer pressed a switch, it released pressurized air from the cylinder into the segmented section, and the arrow stuck out at 90 degrees."

Williams' team built 40 air-arrow rigs, used in conjunction with impalement prosthetics. To ensure a rigid attachment of arrows to performers, avoiding the sag of gravity, Daniel Parker's team created form-fitting polypropylene plates to fit beneath prosthetic pieces and attached several hundred lightweight dummy arrows, fashioned out of rolled tracing paper.

Technicians also fabricated 3,500 rubber-tipped cardboard spears for use in battle sequences in which production mingled stunt performers with local extras. "We didn't want our extras getting too carried away with anything more solid than a cardboard tube," said Williams. "We serrated the underside of the tubes; so, if there was any forward contact, the spears just buckled."

Flying spear effects — seen as Achilles displays his spear-throwing talents — made use of a rig that gave extra oomph to an industry-standard fly-by-wire effect. "In the past we might have rigged a hollow spear on a tensioned piano wire and thrown it by hand," Williams related. "Wolfgang wanted to achieve an impression of 'demigod-ness' with Achilles, so we developed a system to fire a spear down a wire using air. We propelled a 15-pound spear up to 80 feet."

Armorer Simon Atherton collaborated with Williams and second unit director Simon Crane to produce closeup practical swords that were authentic to the period. "Simon Atherton made hero swords out of bronze," said Williams. "We also made dummy retractable swords from copper and gave them a bronze effect. Most retractables are quite delicate, but Simon Crane and the stunt boys ended up killing my swords in every take! So we beefed up the edges to take sideways blows."

The effects department also supplied foreshortened swords — hilts with two-inch rubber stumps — onto which visual effects added digital blades. "Even in an intricately choreographed fight," said Nick Davis, "if we gave somebody a full-length sword, they never looked as if they were hitting their opponents, because they were always holding back. If we gave them a rubber sword, it became a joke. So we decided to use short swords and add blades later. We did that with Brad in nearly all his fights, and that gave him the freedom to really go for it, mowing his way through swaths of Trojan soldiers."

The focus of the attack is the ancient city of Troy, thought to be a mythical location until archeologists unearthed ruins in western Turkey in 1822. To resurrect the city on film, the filmmakers selected Fort Ricasoli in Malta — a Napoleonic outpost overlooking the Mediterranean Sea, which had been the basis for *Gladiator*'s Rome — as the foundation for construction. Production designer Nigel Phelps



Director Wolfgang Petersen marshaled an army of artists for Troy— his epic depiction of treachery and war in 1193

built onto the fort, constructing a main street and a central palace and gardens representing the residence of King Priam (Peter O'Toole).

Petersen initially selected locations in Morocco to represent battlefields and beaches beyond Troy; but political tensions in the region caused production to relocate to Los Cabos, Mexico, where construction crews erected the main gate of Troy and a 400-foot-long, 40-foot-tall section of wall. Adjacent beaches represented a landing site for the invading Greeks.

The expansive physical sets represented only key scenic elements and required enhancement to complete the illusion of the imposing city. Production chose to pursue an entirely digital approach, without any practical miniatures. "One of the most difficult things you can try to do with a large-scale model," observed Nick Davis, "is place it in hard, directional sunlight. Anything flat-lit, overcast or snowy works fantastically with models; even stylized lighting works beautifully. But it's very difficult to make hard-key daylight look real. In the real world, your key light is the sun — a distant, single light source that gives you all the wonderful reflections, kicks and fill of a true, hard-key environment. To re-create Troy with a model — especially in England in the winter — we would have been on a soundstage, using four or five light sources placed 30 feet from the model. There is a certain look that comes from that — which you then try desperately to fix in postproduction, repainting textures and re-lighting and doing everything but what you were originally attempting, which was to capture an in-camera element."

MPC initiated digital development of Troy during preproduction, working closely with Nigel Phelps, who provided profiles of Trojan city skylines. "Nigel designed the bulk of the city and individual buildings of Priam's palace," stated MPC CG supervisor Gary Brozenich. "We had to fill in everything in between." Research revealed Troy had evolved in an organic manner, over hundreds of years. "Troy had seven periods of development. We were at Troy '6A' at the time of our story. Historically, walled cities grow from a central fortified fort or palace where all the inhabitants would flee at times of siege. As the city developed, people built additional walls to protect the expanding populations. Smaller civic centers developed within the walls, which were eventually fortified, as well."

B.C. – based loosely on Homer's The Iliad. The production required some of the largest sets ever constructed on location for a film. In addition to the massive sets, built in Malta and Mexico, the production mingled hundreds of extras, costumes, props and weapons with visceral physical, prosthetic and digital effects. Visual effects supervisor Nick Davis and four London effects studios extended the Trojan city and enhanced its environs with digital crowd simulations.



Hector (Eric Bana), Prince of Troy, returns to the palace of his father, King-Priam, accompanied by the Spartan queen, Helen (Diane Kruger), and his younger brother, Paris (Orlando Bloom). Production designer Nigel Phelps selected Fort Ricasoli in Malta – a Napoleonic outpost

overlooking the Mediterranean Sea as the site for the construction of Troy. The Moving Picture Company collaborated by developing digital models to expand the physical setting, referencing archaeological research of ancient cities. To create the digital cityscape, MPC employed aerial surveys of the sets and sampled digital stills of local scenic textures, then furnished scenes with 3D structures, Trojan bric-a-brac and digital matte paintings. As an alternative to traditional chrome ball lighting reference, artists generated high dynamic range images of sets by photographing environments, using a technique developed by Framestore CFC, whose representatives were on set during the shoot, handling scenes of the Greek invasion.

Artists built layouts using MPC's City Builder, a Maya plug-in for placing 3D building blocks. "We designed ten generic buildings that could be viewed from four different angles," explained Brozenich. "Each side gave the impression of a completely different building. They were quite comprehensive building complexes, each consisting of between six and twelve units split into individual structures. From each of those buildings, we could make between 50 and 80 new ones." A pantry of CG set dressing included canopies, tables, baskets, ladders, pots, ropes, plants, vats, fences and sundry Trojan bric-a-brac.

To provide textures for the city models, visual effects crews gathered more than 5,000 digital stills in Malta. As an alternative to traditional chrome ball lighting reference, artists generated high-dynamic-range images of sets by photographing environments. In a system developed by Framestore CFC visual effects supervisor Jon Thum, artists used a Canon 1DS digital camera with a Sigma 8mm fisheye lens to shoot five bracketed exposures looking north and south, and then combined images in Shake. Both Framestore CFC and MPC used the HDR image capture system through the shoot. "We imported images into University of Southern California's HDR Shop software," related Brozenich. "We unwarped them to produce environment maps and used our own surface shaders to add color to the ambient, diffuse and reflection components in renders."

Nick Davis also engaged Plowman Craven & Associates, an English architectural survey company, to chart aerial maps of the sets. PCA took large-format aerial photographs using a pair of cameras triggered by predetermined global positioning satellite coordinates and calibrated to take overlapping images — producing an illusion of stereoscopic depth, from which 3D data could be derived. "It's quite a common tool in architecture," said Davis, "used for surveying buildings. It was a good technique for capturing a huge mesh of terrain."

To build the environment beyond the city walls, MPC made use of PCA terrain scans of Los Cabos and textured surfaces with production plates. "We wanted to stay as true to the plates as possible," noted MPC visual effects supervisor Chas Jarrett. "Nick didn't want to digitally replace any skies or natural elements because it creates a 'mushy' feel when you overcook effects shots. Once we had our scan of the terrain and we'd done our matchmove, we took the production photography, projected that back onto the plate as a texture map, painted up the texture maps to clean out crew members and camera rigs, and then re-rendered the background."

Referencing Homer's statistics, the script called for 75,000 warriors to clash before the city gates — 25,000 Trojans facing off with 50,000 Greeks. MPC developed digital army simulations as 3D animation driven by artificial intelligence and a motion capture processing system. From analysis of storyboards, Davis and the MPC team determined what percentage of foregrounds would be occupied by live extras, with computer generated characters occupying backgrounds. "We told Nick that our CG characters would never be more than a quarter of screen height," said Jarrett, "but we told our modeling, texture and R&D team to create characters that were at least one-third screen height. We ended up doing some that were almost completely screen height! We only saw their heads, but the heads were the size of a human head, full screen."



Sparta's allied forces race toward the shores of Troy, intent upon recapturing their queen or exacting bloody revenge. Based on an art department design, Marine coordinator Mike Turk built two full-sized 'monoreme' warships on location in Malta. Twin diesel engines beneath the keel brought the 70-ton vessels up to speed. Velocities of up to 14 knots were maintained under oars and sails. All of the ocean-going action was shot on board the practical ships, which also provided Framestore CFC with the lighting reference required to add 1,000 digital ships to backgrounds.

To detail the models, MPC sampled photographic textures of arms, legs and faces, and worked from photographs of costumes to create assorted shields, swords and spears. MPC tested the verisimilitude of the digital soldiers by intermingling models with footage of a live performer, shot in costume on the Shepperton backlot. The performer occupied five different positions, receding from camera; compositors then dotted seven digital replicas around the locked-off plate. When these digital doubles were projected for Warner Brothers and Wolfgang Petersen, they proved indistinguishable from the live-action character.

MPC's research and development team wrote its own crowd software and particle system to bring the digital armies to life. "Maya's particle system held only very simple data types," said crowd system developer Julian Mann. "We needed a system that could hold thousands of skeletons, constantly updated by motion capture poses. So we built our own particle system, and then built peripheral tools that were compatible with Maya, in case we needed to switch back."

The crowd system comprised approximately 80 Maya plug-ins and a motion library editor known as 'MLE' — or 'Emily' — sister to MPC's artificial intelligence software, 'Alice.' MLE fed Alice with animation derived from extensive motion capture conducted at Artem Digital during preproduction and beyond. "We knew the postproduction schedule wouldn't allow us to do all the motion capture we needed," said Nick Davis, "so, before we went off to Malta and Mexico, we did a huge amount of motion capture. We planned to return for shot-specific actions, once we knew what happened in the fights."

MPC devised an 80-page wish list for the motion capture sessions and built variations of generic soldier movement in ‘figure-eight’ motion cycles. Motion editors broke the curves and straight lines of motion into bite-sized motion clips. MLE then provided Alice with combinations of movements matched to characters. “It was a very modular system,” noted Mann. “A lot of small components built up into the overall articulation, which we called ‘Motion Sim.’ MLE was the core of that and could automatically create blends between motion clips. The AI fed MLE requests; MLE then decided which bit of motion capture to apply to characters, based on layouts.”

Layout artists used a custom MPC Maya plug-in, ‘Pixie,’ to paint characters onto 3D terrain. Pixie rendered the characters in 2D, loading images from a turntable of angles as defined by their orientation to camera. “If the art director wanted to see how armies looked from a certain angle,” explained Mann, “artists could very quickly lay out thousands of points with channels representing different armies, grouping characters as needed.” Artists delineated costume types and weapons configurations, while the AI controlled levels of detail at render time, using a range of resolutions — from background stick men to fully-detailed hero models — based on their proximity to camera, computed in a scriptable render engine, ‘Giggle.’

Framestore CFC embarked on its own research and development to determine methods for generating crowd enhancements in scenes that focused around the Greek fleet. Framestore CFC artists shared time on the Artem motion capture stages and adapted MPC’s digital soldier models to their own needs. “Our shots involved people on boats and on the beach doing different tasks,” said Jon Thum. “We didn’t have to develop an elaborate artificial intelligence system for that. We just had to take all our motion capture, organize it and place it in the scene in an intelligent way.”

Artem processed motion capture data into digitally animated skeletons. Framestore CFC then built a character rig that enabled animators to mix techniques, blending keyframe animation with motion capture. “Our system relied mostly on motion capture,” stated crowd system lead Andrew Chapman, “but if characters came close to the screen, it was easier to finesse the performance with keyframe animation than try to manipulate the motion capture.”

Framestore CFC used image-based lighting models to quickly capture large environments. “That was useful,” said Thum, “because we were shooting a lot of huge sets and we didn’t want to interfere too much. We shot high-dynamic-range reference of every significant take and lighting change, recording bracketed exposures ten or twenty yards off to the side of set, without getting in the way of the main motion picture camera.”



Beaching near the Trojan stronghold, Achilles (Brad Pitt) and his troops are greeted by a hail of arrows. Physical effectssupervisor Joss Williams launched harmless prop arrows through shots using air cannons, each capable of firing numerous arrowssimultaneously. Makeup effectssupervisor Daniel Parker supplied prosthetic arrow hits, attaching protruding shafts to performers using form-fitting polypropylene plates beneath prosthetics. In postproduction, Framestore CFC completed the shots with digital arrow simulations, atmospherics and the entire Greek fleet.

The relative ease of recording HDR images also made it possible for Framestore CFC to quickly and efficiently capture CG lighting models on the open ocean, where many of their shots were based. “Wolfgang didn’t want to shoot in a tank,” said Nick Davis. “He wanted to see real ships rowing on the real ocean. Production built two gorgeous ships. We needed a thousand, but two was a good start!” In Malta, Petersen staged scenes with principal actors on board the practical warships, relying on visual effects to surround them with approximately 1,000 vessels, often with a moving camera hovering above the undulating ocean. “It was a very tricky tracking exercise. To analyze the problems, we did some tests in England, dropping buoys into the ocean and photographing them from ground-based cameras and from a boat.”

The tests inspired the development of an ocean tracking system, used by Framestore CFC in Malta. The system involved stringing sets of buoys from two inflatable dinghies. “We used five buoys in each string,” said Thum, “20 meters apart, giving two 80-meter-long strings. The buoys gave us midground tracking data; the dinghies gave us a horizon track if it was misty. We previsualized where our dinghies and our buoys should be in all the shots, relative to camera and the two real boats, then triangulated distances from camera using 2d3’s boujou and Realviz’s MatchMover tracking software.”

Framestore CFC modeled the digital Greek fleet concurrent with a practical boat build. Modelers constructed CG ships in a modular fashion, enabling geometry to be programmed into a digital production pipeline, then assembled during rendering. “In any of our shots of the fleet we had 1,000 boats,” said Framestore CFC supervising technical director Laurent Hugueniot. “Each ship had a crew, splashes, oars, sails, rigging, props — all of which would have been very difficult to program inside Maya, even for one ship. So we had to make a system in which we could assemble prefabricated boat components at render time. The system was based on a library, which we populated with animation, simulations and different parts of geometry for each ship.”

Three hull sections and a distinctive bow and stern comprised Achilles’ ship. Framestore CFC built other warships and cargo vessels using three varieties of hull and four configurations of bow and stern, with shields and side ornaments signifying army liveries. Technical directors could design specific ships or the computer would randomly assign and group details from ship to ship.



Wolfgang Petersen devised an aerial shot that soars over the beach to reveal hundreds of warships landing on Trojan shores, expelling several thousand Greek invaders. Helicopter plates for the shot featured no ships and only a minimal number of costumed extras representing the assault force. Guided by previsualization, the filmmakers placed scattered groups of extras on a beach in Golden Bay, Malta, with 200 clustered in the far background where the aerial camera would swoop down. Tracking markers dotted the two-mile expanse.



To depict the massive fleet, Framestore CFC artists created Greek warships and cargo vessels via a modular digital construction pipeline. Modelers generated a variety of vessels by mixing and matching three hull segments, four bow and stern segments, and ornaments signifying seven

The most relevant details in distinguishing the ships were the sails. Framestore CFC generated 30 sail insignia designs, based on Hellenic icons, and assigned 100 different tint values to create varieties

of fabric. “There was a lot of detail in the sails,” stated CG supervisor Ben Morris. “We had bumps, stitching, creasing, and fill and bounce lights from the sea interacting with the strong key-light from the Maltese sun. Our first perceptions of how sails should look were based on modern yachts, which have membrane-thin sails with huge translucency. When we went to Malta, we saw that the real sails were made of dense, heavy cloth and were only slightly translucent when backlit by the sun.” To match the practical sails, Framestore CFC incorporated a measured bidirectional reflectance distribution function into its shader, using a reflectometer to sample readings from actual sail fabric.

Sail behavior employed Syflex cloth simulations as a plug-in to Maya and keyframe animation that allowed animated sailors to interact with the sails, grappling rigging as fabric was buffeted by wind and rocked by ocean currents. The complex animation chain included from 50 to 100 motion captured performers per ship, translating to close to 50,000 soldiers in aerial shots of the fleet.

All the ocean scenes began as live-action plates; but to generate bow waves, foam, oar splashes and wakes, Framestore CFC used combinations of live and computer generated effects. Thum shot bow wave elements of a boat cutting through the sea in Malta. Technical directors projected live bow waves onto CG hulls and combined them with matte passes of Maya particle animation and fluid simulations to represent oar splashes, intersecting ripples and trails of glassy calm behind ships.

Fleet composites put the Framestore CFC pipeline to the test when Warner Brothers called for one of the film’s most demanding shots to be delivered for a special teaser trailer, six months before scheduled delivery. Filmed by a helicopter pulling away from the dinghies and retreating for approximately one mile, the shot comprised over a minute and a half of footage, accelerated to 30 seconds, and in the final composite featured close to 1,000 ships. “Everything had to work for that shot,” said Laurent Hugueniot. “We had massive rendering overheads and we had to completely rethink our render pipeline. We used in-line archives to assemble the animation, shaders and geometry, which made the boat generation almost instantaneous.”

The film opens in Thessaly — represented by locations in Mexico — then moves on to Aegean sites, shot in Malta and enhanced by Framestore CFC digital matte artists Jason Horley and Nathan Hughes. Menelaus’ home of Sparta included 2D paintings and projections of high dynamic range textures onto 3D geometry. “A lot of natural environment was already in the plate,” noted Framestore CFC 2D supervisor Gavin Toomey. “We removed contemporary buildings from the background, and added matte-painted palaces. For Mycenae, the plate was pretty barren, basically just a hillside. We added the harbor, ships and buildings and tried to make structures feel aged, adding rubble to break them down. We relied heavily on location photographs of historic Maltese buildings, which were invaluable reference.”

As the narrative takes to the high seas, the filmmakers made use of practical warships, without any land-based gimbal rigs. “We shot everything on the ocean with actors on the boats,” explained Nick Davis. “When the fleet set sail, that meant we had to place 1,000 ships into backgrounds, with a

army liveries. Technical directors assigned geometry to specific ships, or allowed the computer to assign details on a random basis. Each ship had interactive rigging, oars, props, sails and up to 100 motion captured characters.

moving camera on a moving ocean.” In addition to seaborne marker buoys, 3D artists used glimpses of land on the horizon to help track shots, and made use of practical ships for lighting reference within plates. “We parked our second ship in the background as often as we could. It was the best reference we could have for contrast, exposures, or depth of shadow detail in our CG ships.”

Details invested in CG vessels required careful evaluation during composites, particularly in the establishing pullback from the fleet. “We could make a 3D boat look fantastic close up,” observed Gavin Toomey, “with all its photorealistic qualities; but as soon as we moved it into the distance, it became very difficult to retain all the textures in the cloth and wood. We tried not to be too precious with detail, dialing back the highlights to bury ships into the scene.”

Compositors juggled atmospheric haze, falloff and exposure values, using data obtained from high-dynamic-range images. “We used our HDR images to light beauty passes,” said Ben Morris. “We then created component lighting passes split into RGB channels. We used our blue channel as bounce light from the sea; the red channel represented keylight from the sun; the green channel was fill from the sky. We had to constantly juggle those parameters to create contrast between key to fill ratios.”

Achilles is the first to land on the Trojan beach — shot on location in Golden Bay, Malta, using a practical effects rig to create the action of the ship plowing into the sand. “The real ships were too heavy to do that sort of thing,” explained Joss Williams, “so we built the front 40 feet of the ship around a huge, six-wheeled amphibious vehicle we found in Malta. We fabricated the bow out of fiberglass, added a deck and mast, and put about 15 people on board. We reversed it out into the bay, into about eight feet of water, then drove it full-tilt and plowed the nose into the sand.”

Physical effects played a role as a storm of Trojan arrows rains onto Achilles and his men. Williams’ team rigged air arrows to impale actors and props and used mechanical effects to portray more elaborate effects of victims falling in the charge. “Simon Crane wanted everything on the move,” said Williams. “He didn’t want the traditional insert effect, cutting to a stationary prosthetic; so we built air-operated, articulated dummies, weighted and jointed to crash-test-dummy specifications, and attached prosthetic pieces.”

Daniel Parker and a trio of makeup artists applied prosthetics to stunt personnel and special amputee performers, in collaboration with the production makeup department led by Paul Engelen. “We created foam latex prosthetic limb extensions for two arm-amputees and one leg-amputee,” said Parker. “Simon Atherton advised on the effects of bronze-age ballistics, and we severed the prosthetics using real bronze weapons. Bronze has a very distinct way of attacking flesh. I did a lot



Greeks dig in on the beach and fortify their encampment with barricades along the dunes. The art department constructed an encampment set that included four full-scale beached ships, built from castings taken from the practical ocean-going vessels, and masts planted in the sand for background scale reference. Framestore CFC enhanced the encampment scenes with 3D crowds, horses, structures, tents and hundreds of ships extending to the horizon. Seen in a variety of lighting conditions through the film, the encampment extensions used mostly rendered elements, rather than matte paintings, made possible by the efficiency of the boat render pipeline.

of tests on *The Last Samurai* with real Samurai swords, which could literally go through flesh and bone like butter. Bronze weapons are more like a hammer. They're not that sharp, and they blunt very quickly; so it is more like someone has been in a car crash."

To launch flocks of arrows through shots, physical effects supplied eight racks of air cannons, each capable of firing up to 60 arrows simultaneously. "We fired as many real arrows into shots as were feasible," Nick Davis remarked. "There is always the problem of getting flying arrows to read on camera, and they can be quite dangerous; so we also added a lot of CG arrows and flaming arrows with wispy trails. We sometimes started with a flaming arrow on a stuntman, digitally removed that in the beginning of the shot, then tracked in a CG arrow."

Framestore CFC provided extensive Maya and Houdini arrow simulations, smoke and armada effects for Achilles' beach landing, during the complex 'tortoise' shield formation of his Myrmidon crack troops. As backdrop to the mayhem, artists furnished the incidental detail of the entire Greek fleet racing to join Achilles. "We tried to persuade Simon Crane not to direct his shots out to sea too much," explained Davis, "because every time the camera pointed out in that direction there were 1,000 ships missing. Simon promised me he wouldn't — and promptly did so about 50 times!" Shot predominantly handheld, the sequence required extensive 3D tracking to layer the armada onto the ocean as Achilles and his men storm the beach. "We added a lot of 2D practical smoke effects where Achilles' boat was burning," related Gavin Toomey. "We integrated the armada with atmospheric elements, so it became more a subliminal suggestion of 1,000 ships and would not detract from the foreground action."

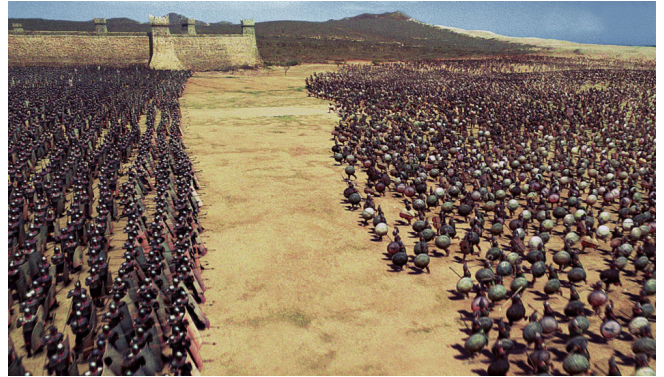


The Greek army marches on Troy. Five hundred extras enacted the battle before a 400-foot full-scale length of city wall built in Los Cabos, Mexico. The Moving Picture Company digitally expanded the environment and populated the terrain, increasing the live performers to an army of 75,000. Charged with creating digital combatants that would occupy no more than a quarter of screen height, MPC developed CG soldier models and fed motion capture data of performers into a proprietary crowd simulation system that combined artificial intelligence with a motion library editor and Maya plug-ins.

Cinesite shared postproduction duties on later portions of the sequence — visual effects supervisor Sue Rowe overseeing the addition of up to 1,000 digital arrows in Maya and Shake, and digital sword extensions. "We built a 3D sword extending about two feet from the hilt," related Cinesite 3D animation supervisor Jonathon Neill. "We tracked that to a 3D model of a human torso with arms, which gave us a three-dimensional form to track to actors' bodies. The shots were so fast and well-choreographed, contact points worked really well. Our main problem was motion blur. As swords swung through frame they tended to lose highlight information. We counteracted that in 2D by dialing up the specularity. There were a lot of highlights coming off the performers' armor, so we used those to gauge the highlights on the blades and matched motion blur to the stump on the foreshortened sword. We then painted out the dummy stump and put the CG blade on top."

The sequence concludes with an aerial shot that swoops over the Greek invaders as they pour onto the beach. "The armada landing was one of the first shots Wolfgang described in our initial meeting," recalled Nick Davis. "He wanted a helicopter shot flying over the beach, looking down on

all the ships as they hit the beach, tilting up to reveal thousands of men jumping off the boats. It was his vision for the movie.”



After a tense standoff, the amassed Greek army charges the Trojan defenders. Production captured the attack using a wire-flown, motorized camera rig that traversed the battlefield, diving from 60 to 12 feet above the ground on the Los Cabos location. Referencing MPC animatics, the filmmakers situated a square of live performers at the lowest point on the camera's trajectory. MPC then created crowd extensions in London by motion-capturing stunt performers hurling themselves over padded crash barriers. Digital artists painted out camera rigs, roto-scoped live performers and blended digital doubles enacting death-defying stunts.



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Framestore CFC translated Petersen's vision into a vista containing 6,000 characters, with 40 vessels landing and several hundred more out on the water — built from a production plate featuring zero ships and a scattering of 400 extras. "We previsualized the shot to decide where we wanted to place real people," explained Jon Thum. "In the previz, the camera tilted up near the end of the shot, so we placed most of our extras at the far end of the beach, with a few others sprinkled along the way; and we had tracking markers every 40 meters for a couple of miles. The final shot tilted up a lot earlier than planned, which left us with a lot of empty beach before we reached real people."

Tracking markers provided a lock on the beach, but the seaborne half of frame and diversity of crowd animation made the shot one of the most demanding for Framestore CFC. "We painted in the crowd using a density map function," remarked Andrew Chapman. "That approximated the number and positioning of people. We then went through the arduous process of creating a more natural looking layout, grouping people around boats and dropping in set-piece animations to bulk up the crowd." The simulation featured approximately 1,000 motion capture clips, controlled by a motion index system that enabled animators to pinpoint members of the crowd. "We had instant feedback within Maya so we could manipulate characters and adjust their moves, but we had to focus on the whole length of the beach because we saw each portion of the crowd close up at some point. There were people running up and down, leading horses off the boats, carrying props. We threw every tool we had at that shot."

2D artists digitally repainted the beach terrain and mapped textures back over the beach to help lock 3D elements. Then they blended CG boats into the ocean by creating interactions between real water and 3D water where motion captured characters were seen splashing through waves. Live performers provided reference to help match animated characters to the plate. "The live-action helped us grade and scale our CG characters," said Toomey. "That helped us create correct shadow values without making the shot feel too 'heavy.' We tried to



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keep a range of densities to differentiate armies, enhancing highlights on some while dialing others down.”

Later views of the Greek beach encampment featured Nigel Phelps’ expansive set enhanced with Framestore CFC digital extensions. “We added a lot of 3D crowd,” stated Toomey. “In a couple of shots, we took existing tents and placed them into backgrounds with 3D tents, 3D horses and structures. We had to finesse some of the crashing waves on the Mexico plates to match our Malta plates, which had a slightly different color to the sea. Our 3D team designed the beach encampment extensions, which incorporated thousands of CG soldiers and the entire beached armada.”

Troy prepares for war as 50,000 Greeks advance on the city. Practical elements of troops on the march included ten horse-drawn chariots fabricated by physical effects, adapted from production designs.

Chariots and horses featured into MPC’s crowd system pipeline as keyframe animation that informed AI characters. “Agents understood where the chariots were,” explained Julian Mann. “They could be told to follow, move out of the way or attack. The horses and chariots didn’t react unless we keyframed them to do so, but they could plow through agents, who would all react.” Mapped across the Los Cabos terrain, the Greek army featured swaths of motion captured soldiers rendered in Giggie. “We rendered armies in a lot of different passes. Compos-itors blended all the layers in Shake, almost as if they were re-lighting in 3D, but in the 2D realm.”

The conflict outside the city plays out with a standoff between armies as leaders from the opposing camps attempt to settle their disagreement in a duel: Paris versus Menelaus, surrounded by 75,000 men. “It was a huge sequence,” commented Nick Davis. “We had a couple of hundred background extras on set, but we almost gave up on them. We figured that if Paris and Menelaus were standing in the middle of the battlefield, with Trojans 300 feet one way, Greeks 300 feet the other way, our field of view required effects in every direction.” Shot mostly with a Steadicam, with no bluescreens, the sequence required heavy rotoscoping and luminance keying at MPC to separate actors’ flowing hair and costumes from backgrounds. “The armies were relatively static at the beginning of the fight, so we were able to treat them in a slightly 2½D approach, tracking them in either side, with the wall of Troy and the palace of Troy behind the real wall. We had this fantastic fight in the foreground, with all the natural lighting; and because we didn’t have to rebuild any of the terrain, it looked amazing.”

The Paris/Menelaus duel gives way to a ferocious 14-minute conflict, a display of primitive battle tactics dubbed the ‘Battle of the Arrows.’

“It was a giant scrimmage,” said Davis. “The strategy was simple: ‘There’s the enemy; let’s have a go at them.’ One side rushed at the other and the stronger team overturned the weak, with nutters leaping over the top stabbing them to death, and thousands of people prodding one another with spears until there was no room to move. It was ugly, tight and constrained; a really nasty affair.”

The scene features a high-speed camera move that dives into the fray, staged with a wire-flown camera rig by Aerial Camera Support. MPC prevized the shot, depicting Greeks charging into static ranks of Trojans, the camera swooping from 60 to 12 feet, skimming soldiers’ heads. The previz

became a guide for ACS, which erected a motorized, computer-controlled camera suspended from cables over the battlefield and enacted the high-speed move.

The filmmakers positioned a small square of performers at the lowest apex of the camera's path — intermingling approximately 500 extras with 60 stunt performers. "The real guys were supposed to be seen in closeup as the camera swooped down really close," said Chas Jarrett "But as the camera descended and the real guys clashed, there were huge gaps in front of and behind them. There just weren't enough extras to go around. So we had to fill in with CG characters. It took a lot of R&D to get our CG guys to look as if they were really clashing."

MPC returned to the Artem motion capture stages during postproduction to plug the gaps, using the shoot stuntmen as motion capture actors. "It helped to have the stuntmen," said Jarrett, "because they really knew how to swing a sword. In fact, we redid a lot of our existing motion capture with those guys because they had such an amazing physicality." Performers used specialty props on the Artem stage, wielding wire-mesh shields that would not occlude their bodies, and pummeling and vaulting padded crash barriers for the charge.

Compositing the huge quantities of geometry in the Battle of the Arrows required multipass render technology. "We were blending up to 24 passes per rendered frame," remarked Jarrett. "We had seven or eight basic passes — including specular, reflection and shadows — then 12 or 13 specialized passes for metal, leather, skin, cloth and so on. That way, we avoided rendering the same image over and over. Compositors could control a single CG character by simply clicking on the agent to create a matte."

MPC 2D supervisor Rudi Holzapfel and a team of 24 rotoscope artists — led by Giuliano Vigano — worked on the film for a solid year and integrated thousands of digital characters, spears, arrows and flailing swords.

In reply to the Greek assault, Trojans attack the invaders' beach encampment in a nighttime raid that takes Greek forces by surprise. The attack begins with Trojan archers shooting burning arrows into the Greek camp — a digital composite featuring burning arrow elements shot at Shepperton. "Simon Crane wanted the burning arrows to come over as a surprise," remarked Williams, "but 300 arrows at night created light pollution from their flames, giving the surprise away; so we shot burning arrows as elements for CG to add later — burning arrows impacting the ground, impacting the boats, and so forth. We had to use a special pyrotechnic fuel, soaking every arrow and then drying it out before it would ignite. It was an absolute pain in the arse!"

Cinesite used a mix of three practical flame effects, as arrows landed in the sand and jettisoned embers and smoke. Procedural scripts guided trajectory arcs; combinations of effects then kicked in on impact. 3D arrows were layered with 2D practical elements and rendered in passes of 200 to 400 projectiles, enabling compositors to layer shots and create depth effects.

For a subsequent fireball attack, the special effects crew fabricated 20 six-foot-diameter spheres, made out of flame-retardant fiberglass, coated in carpet underlay and wrapped with chicken wire and tumbleweed. Pyrotechnicians doused the props with gasoline and paraffin, then stunt performers hauled ropes mounted on each side, dragging the spheres over burning arrows, and flung the fiery missiles. Pyrotechnic impacts were shot full-scale using 100 fireballs and Los Cabos

technology. “The local piñata guy made our impact fireballs,” related Joss Williams. “We wrapped the papier-mâché in chicken wire and underlay, and got two or three takes out of each one.” Cinesite used burning fireball elements, filmed spinning on a spit, to extend practical pyrotechnics — shrinking, animating and compositing fireballs the length of the beach — and enhanced fireball impacts with warships using practical spark and ember elements.

The death of Achilles’ young cousin, Patroclus (Garret Hedlund), sets the final act of the film in motion, sending Achilles on a quest for vengeance, resulting in a duel with Hector (Eric Bana) outside the walls of Troy. Late in the shoot, a hurricane destroyed portions of the set, requiring a pickup session months later and additional visual effects by Lola. The combatants used shortened swords and dummy weapons to exchange close and furious blows. “We added CG swords and straightened or replaced rubber spears,” said Lola visual effects supervisor Rob Harvey. “We also extended the city, adding a piece of wall and tower at one end. We made our own digital matte paintings from scans of 30 shots in the sequence, projected in XSI, tracked in 3D Equalizer and composited in Shake or Flame. The other houses had been working on the show for a year by the time we came on board, so the pipeline had been set up. Their roto-heavy approach really helped.”

Achilles exacts his revenge on Hector and desecrates the prince’s corpse by dragging it behind his chariot. Daniel Parker’s team built a weighted, articulated likeness of Eric Bana for the scene, cast in a durable polyurethane that was detailed enough for closeups but durable enough to withstand dragging at high speed. Makeup artists sculpted prosthetics and applied them to Bana in subsequent scenes of Achilles hauling his prize into the Greek camp.



The Trojans mount a counter-attack, hurling fireballs into the Greek beachfront barricades. Joss Williams’ team fashioned full-scale fireballs from fiberglass spheres covered in combustible materials, and impact fireballs from similarly clad papier-mâché. Cinesite extended the setting and enhanced the attack by digitally replicating practical fire elements and laying them into the scene, along with cascades of burning arrows – 3D arrows blended with practical elements. Combinations of procedural effects kicked in on arrow impact.



Twelve days after the battle of the barricades, Trojans discover the Greek encampment vacated and assume victory – until a lonerider stumbles on the entire Greekfleet laying in wait in a nearbycove. Production staged the scenewith only one practical warshipanchored in the bay. Framestore CFC used that practical warship as lighting reference, rotoscoped foreground elements from the bay, digitally repainted midground coastal features to accommodate more ships, and tracked in nearly1,000 vessels, layering distantships with atmospheric haze.

The story picks up twelve days later, on the Trojan beach, with the discovery of a giant wooden horse, built from the remains of burnt warships, left by apparently departed Greek troops as an offering to their gods. Production constructed the horse as a 42-foot-tall prop, designed by Nigel Phelps and filmed on two continents. “We had a full-scale wooden horse in Malta in the main square,” stated Davis, “and then we rebuilt it on the beach in Mexico. We built it for real because it was always seen with people in proximity to it.”

The art department created a foot-tall wood maquette of the horse, from which it devised schematic drawings. Construction teams scaled up the design in collaboration with physical effects. “They built a 17-ton metal frame,” related Joss Williams. “We then had to move it through the streets of Troy. We did it by the old-fashioned method of rolling logs. Each log was 14 feet long, a foot in diameter. There were only two lathes in Europe big enough to handle trees that big, so we ended up importing 40 logs from Holland.” Williams’ team tested the roller-logs at Shepperton utilizing a 20-ton weight on a dummy base and a loop of wire on offset pulleys, connected to a Caterpillar

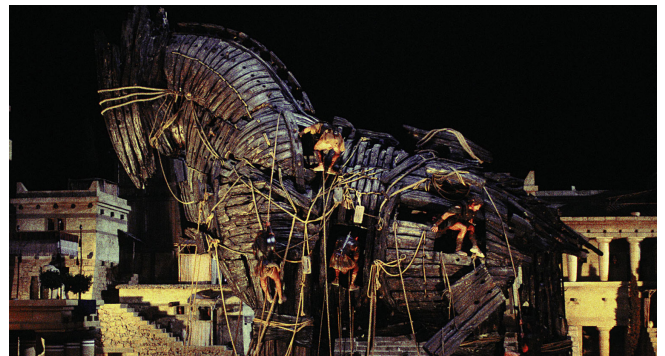


truck and tension meter. “We found that we only needed a ton of force to move 20 tons. For shots of the horse moving through the streets, we used the truck pulling from off-camera. In shots with 300 extras pretending to pull the horse on ropes, the crowd sometimes got out of step with the truck and, when it stopped, they kept pulling and ended up towing the horse by brute force.”

The giant prop was clad in fiberglass, textured with a burnt-wood finish, and fitted with multiple trapdoors, through which Achilles and his men exit under cover of darkness to open the city gates for the Greek army, which sets about burning Troy.

Maltese physical effects lead, the late Mario Cassar, helped supervise the pyrotechnic rigging of the Fort Ricasoli set. The two-week shoot required 16 weeks to prep, with more than four miles of metal pipe, fueled by five 5,000-liter liquid propane tankers — creating the illusion of an inferno that slowly consumed the city. “It was one of the biggest controlled burns ever done on a movie set,” noted Williams. “The burning of Atlanta in *Gone With the Wind* was a one-off, because they just torched the set. Ours, we could turn on and off.”

Effects technicians worked in collaboration with the art department to place strategic fires in rooftops and windows, which were then redressed with charred set pieces in preparation for the next stage of the burn. Effects teams shot additional pyrotechnic elements in Malta, including a combustible house-sized cube with doors, windows and Trojan architectural features, painted black and rigged to burn.



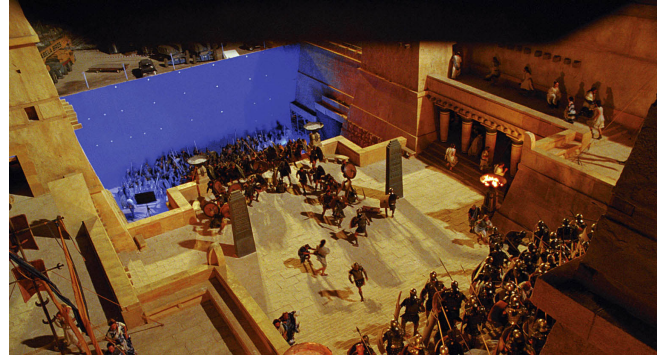
Trojan citizens rejoice at the sight of a giant wooden effigy of a horse, found on a nearby beach, presumed to be The Departed Greeks' peace offering to their gods. The production first realized the full-scale prop as a foot-tall maquette, then scaled it up to a 42-foot-tall, 17-ton metal frame, clad in fiberglass. The physical effects team employed an off-camera tractor to haul the horse over custom-milled logs imported from Holland. / Under cover of darkness, Achilles and his men emerge from the horse and set about destroying Troy.



Greek soldiers storm through the burning city. Joss Williams' team worked with the production art department and construction crews to rig the giant Troy set for a controlled pyrotechnic burn. The effects crew spent 16 weeks dressing the set with some four miles of metal pipe, fueled by five 5,000-liter propane tankers. To create the illusion of the mostly stone city being slowly consumed by flames, technicians placed fires in rooftops and windows, which were then redressed with charred set pieces, ready for the next stage of the conflagration. The burning of Troy was filmed over the course of two weeks.



Greek soldiers swarm the Trojan palace steps as flames sweep through the city behind them. MPC provided burning city vistas, incorporating pyrotechnic elements of burning houses, window elements and collapsing debris mapped to geometry of its CG city, inspired by reference of the World War II London blitz. The destruction of the city made use of Industrial Light & Magic's high dynamic range image file format, OpenEXR, which allowed compositors to dial in interactive light, smoke and atmospheric effects to painterly effect.



Bluescreens were erected to provide separation between the swarms of Greek soldiers and the city in flames behind them. 3D artists split burning city images into layers, while compositors added levels of smoke and haze. Director of photography Roger Pratt collaborated with MPC in digital grading sessions that set the look of the sequence, bathing the city and its digital extensions in a wash of blue moonlight and orchestrating areas of invasive firelight as the city succumbed to the flames.

Visual effects took the sequence to the next level. “We had many shots looking out over the city,” noted Nick Davis. “We had angles from balconies, angles of Achilles’ men storming up the steps of Troy to the gardens 150 feet above the city. We had to hook our CG army into a real army and place the whole city burning behind them; and then, in Achilles’ final scene in the palace gardens, we had 60 shots of Troy burning behind him.”

Jim Rodnunsky’s Cablecam team staged swooping aerial shots over the streets of Troy using a dual high-line system, a computer-controlled camera that rode cables suspended over the set, precisely describing complex 3D moves. MPC developed burnt 3D city extensions and incorporated multiple pyrotechnic elements of burning houses, window elements and collapsing debris mapped to geometry of the CG city, creating vistas of the city in flames, based on World War II London blitz reference.

To composite the sequence, MPC employed new technology in its 2D pipeline. “One of the biggest learning curves for us on Troy,” related Rudi Holzapfel, “was our use of ILM’s high-dynamic-range image file format, OpenEXR. We used that because we were afraid that a normal 16-bit TIFF image couldn’t capture the range of light we needed from bright, burnt-out light to the darkest, deepest shadows, while maintaining textures. It proved invaluable for burning city shots because it enabled us to retain detail in the shadows, especially in foregrounds where the core of the fire was not only white. We could assign a color — magenta-white, or yellow-white, whatever we found in the plate.” 3D artists split burning city images into layers, allowing compositors to dial in interactive light, smoke and atmospherics. “We added layers of haze where buildings had been burning for a while and built that up as the sequence progressed. Other times, we added CG and practical smoke winding through streets and curling around blocks.”

Achilles suffers mortal wounds to his heel and side after attempting to rescue a former lover, Briseis (Rose Byrne), from Priam’s palace. The makeup effects team positioned Brad Pitt’s leg through the set floor and applied a prosthetic leg behind his knee to simulate a kneeling stance.

Joss Williams' crew rigged a wire-flown arrow fired under pressure into the prosthetic heel, then followed with an air arrow in the actor's side. Achilles staggers to his feet but is struck by three more arrows — wire-flown effects on Pitt, combined with 3D impacts tracked to the actor and prosthetic after-effects.

Achilles' death was a key scene for MPC, which established a range of looks for the film in grading sessions with director of photography Roger Pratt. "For Achilles' run through the burning streets to his eventual death," commented Rudi Holzapfel, "Wolfgang wanted a gritty, dark, unpleasant look that created the feeling that Troy was going to be burnt to ashes and every man of Troy was going to die. We lit the palace with very distinct blue moonlight, with little flambeaus as havens of safety; then, as the city burned, the fire slowly took over that color. I have never worked with a DP like that before. Roger was extremely forthcoming with information as to how and why he achieved certain looks and where he wanted shots to go. The production realized, I think, that without that input, the visual effects might not look as good as they could."

Final shots of Troy on the day after the attack, seen from a distance as survivors emerge from a subterranean passageway, reveal the city burnt and smoldering — a digital matte painting that concludes the film, executed by MPC.

Remarkable speed and efficiency characterized the Troy production. Despite its epic scale, natural catastrophes, and midstream relocation from Malta to Mexico — a military-style maneuver achieved in a 22-hour period by filling two 600-ton Antonov cargo jets — the film went from screenplay to answer print in 24 months. The feat was made possible by careful planning and the implementation of well-oiled technological innovations, particularly the ability to add photorealistic enhancements to grandiose live-action plates. "We had an enormous set and 400 feet of wall on location," said Nick Davis. "But apart from that, all we had were two ships, 400 extras and a great big empty battlefield."

An understanding of how to wield the digital enhancements was a factor that figured as much into the design of the visual effects as it did into the filmmakers' craft, shaping characters against the epic backdrop of the story. "The plan was to focus on the foreground and make backgrounds incidental," Davis concluded. "The more incidental they felt, the more realistic they became. I think we captured that with our battles. There were 50,000 people battling it out, but the viewer's attention was on characters in the foreground. That helped sell the effects, and made the scenes real and brutal."

Troy photographs copyright © 2004 by Warner Bros. All rights reserved. Production still photography by Alex Bailey and Simon Smith-Hutchon. Additional photos courtesy of Framestore CFC, The Moving Picture Company, Cinesite and Joss Williams. Special thanks to Colin Wilson, Jennifer Teves, Jeff Walker, Martin Parker, Martin Hobbs, Sophie Trainor, Helen Arnold, Sharon Fitzgerald, Abbie Tucker-Williams, Debbie Streeter, Mick Mayhew and Risa Chapnick.

Freeze Frames

image

ARTICLE BY JODY DUNCAN

As visual effects supervisor Karen Goulekas turned the last page of Roland Emmerich's screenplay for *The Day After Tomorrow*, she had one overriding thought: "Oh, my God... he's gone insane!"

It was a reasonable response. Emmerich had shown a penchant for high-energy, dynamic effects sequences with previous projects such as *Independence Day* and *Godzilla*; but *The Day After Tomorrow* would be his most ambitious — even audacious — cinematic venture to date. A story about the calamitous effects of a sudden global climate shift, *The Day After Tomorrow* would feature stormy oceans, tornadoes, floods, hailstorms, and a massive supercell weather system that encases all of the Northern Hemisphere in ice. In terms of effects, *The Day After Tomorrow* was *Twister*, *Deep Impact* and *The Perfect Storm*, all rolled into one — the Mother of All Disaster Films.

A cautionary tome by authors Art Bell and Whitley Strieber titled *The Coming Global Superstorm* — which interspersed fictional scenarios with nonfiction reportage — inspired the screenplay by Emmerich and Jeffrey Nachmanoff. "One of the scenarios had Americans evacuating to Mexico when this *Ice Age* happened in the Northern Hemisphere," Emmerich said. "Another scenario involved a group of schoolchildren surviving in the New York Public Library by burning books for warmth. I thought that was a great image. Out of those two scenarios, we formed a story — condensing the timeline of the climate shift and storm to work in a movie."

Brought onto the project at its inception, Karen Goulekas and visual effects producer Mike Chambers worked with Emmerich to break down visual effects shots, then assembled a nine-person previz team to conceptualize the film's 'storm tide' sequence, in which a massive tidal surge floods all of Manhattan. "We bought a New York City database from Urban Data Solutions," said Goulekas, "which allowed Roland to play with camera angles. The previz had a very crude shape of a storm tide moving through the buildings, just to give us a sense of timing." The previz unit followed up with animatics for a twister sequence and others, working throughout production, which was based in Montreal. In postproduction, the previz unit's supervisor, Joshua Kolden, formed his own company, Crack Creative, which continued to create 'post-viz' animatics for the film.

A continuous three-minute shot flying over an ocean dotted with icebergs opens the movie, the camera finally settling on a mobile camp of tents and equipment parked on an enormous Antarctic ice shelf. All of the imagery in the flyover was CG, as was 90 percent of the camp environment, the set for which consisted of a few tents and a couple of vehicles on a Montreal stage, surrounded by bluescreen. "I was scared shitless!" admitted Emmerich, recalling the minimal set and his entrusting of the sequence to the visual effects teams. "We had to create a whole digital environment because, later in the scene, the ice shelf begins to crack and break up — which could only have been done in CG. Rather than go from a live location and try to match it in a CG environment, it was better to hook up to that scene with this all-CG flyover."

The two-year-old, 40-person effects house, Hydraulx, did the opening flythrough, simulating aerial ocean views via a Maya shader network rendered in mental ray. To achieve immaculate photorealism in the digital icebergs, founders Colin and Greg Strause hired modelmaker Dan O'Quinn to sculpt 15 miniature icebergs out of foam. "We scanned the iceberg miniatures with a handheld laser scanner," said Colin Strause, "which gave our CG modelers a good starting point. It was the fastest way to get through such a massive modeling task." Modelers also used the digital iceberg geometry to create the ice shelf. "We took five or six different icebergs that we liked, stitched them together and warped them to make one giant expanse of ice. Then we had the sculptor build a custom front face of the ice shelf, scanned that and modeled it in CG." Hydraulx added CG mountains in the distance and terrain details to the flat ice surface.

Subsurface scattering — typically associated with the rendering of flesh — produced the translucent look of the ice. "Subsurface scattering simulates light shining through a translucent material," explained Greg Strause. "Wherever the ice was thin, we needed to have sunlight glowing through it, which is what the subsurface shader gave us. Without that, the icebergs and the ice shelf looked like pieces of white plastic." Hydraulx employed Maya Fluids and particle systems to create wispy snow blowing over the expanse of ice. For late-afternoon Antarctic skies, the brothers photographed days' worth of sunrises and sunsets from the balcony of their condo, tiling them together in a 360-degree panorama.

When it was done, the 4,000-frame shot comprised approximately 40 million polygons and nearly a terabyte of information — a potential rendering nightmare made manageable through custom programs written by programmer Chris Haney. "Chris wrote a dynamic scene-building program for Maya," Colin Strause explained. "We would have temporary, simple, low-rez polygon representations of every object in the shot, and his program would render that frame and save all of those objects separately on the hard drives — so they actually weren't in the file itself. The program dynamically built the shot frame by frame, while it was rendering, only loading the objects that were either seen in the frame or seen in a reflection. As soon as that object left the frame, the program would instantly kill it. We automatically assigned shaders to the high-rez as the scene was being built."

For the end of the flyover, as the aerial camera finds the mobile camp below, Hydraulx added CG structures, vehicles and characters. The opening shot cuts to live-action of climatologist Jack Hall (Dennis Quaid) and his crew drilling cores in the ice shelf for study. In the course of the drilling, the ice shelf begins to crack, releasing a chunk of ice the size of Rhode Island. Special effects supervisor Neil Corbould and his team provided styrene 'ice' dressing for the area immediately surrounding the actors, rigging a piece to break off and drop eight feet into a set hole for a shot of one of Jack's crewmembers falling into an ice shelf crevasse.

Hydraulx realized wide views of the ice shelf action, approaching it as a character animation assignment. "Early on," remarked Goulekas, "we had explored procedural means for breaking apart the ice shelf, relying on simulations to re-create the true physics of it. It was accurate — but it didn't look good. When Hydraulx came on the show, they had their three



best character animators hand-animate all of these ice pieces breaking off. It looked fantastic.”

“Physics simulations are very unpredictable,” Greg Strause added, “and they wouldn’t have worked for this sequence. We had to hit specific, choreographed beats, and we had to match the eyelines of the actors reacting to the make-believe cracking — so it was better to animate all of it. We ran little dynamics simulations for the initial cracking, but all of the pieces breaking off and falling and all of the collisions were animated by hand, using Maya.” Maya particle systems generated smaller bits of ice debris, with a Stroika plug-in simulating shading and lighting in the particle systems.

For The Day After Tomorrow – a film that explores the dire consequences of global warming on the earth’s climate – director Roland Emmerich enlisted a veritable army of effects artists to realize catastrophic storms, floods, tornadoes and other extreme weather phenomena. Among the effects vendors was Hydraulx, which created all-digital views from space of a massive supercell storm that encases the Northern Hemisphere in ice. Hydraulx hand-painted extremely high-resolution cloud-formation texture maps to simulate the clarity and detail of real satellite photographs.

The breaking ice shelf, rising ocean temperatures, strange migratory behaviors in birds, and unusual storm patterns across the globe — tracked from a space station — all foreshadow the coming of the supercell storm. To realize two shots from space of the supercell moving over Manhattan, Roland Emmerich turned to Volker Engel — his visual effects supervisor on *Universal Soldier*, *Independence Day* and *Godzilla* — and Engel’s Dreamscape Imagery team, which had a small window between projects. Hydraulx executed the other shots from space, including those seen later in the film, which reveal the entire Northern Hemisphere covered by the storm mass — something for which there was no real-world reference. “The eye of this storm is the size of Connecticut,” Colin Strause observed. “We looked at hurricane reference to give us an idea of what this storm would look like; but a hurricane, in comparison, is just a little speck.”

Hydraulx matte painters hand-painted enormous cloud-formation texture maps for the all-digital shots of the supercell from space. Many of the texture maps had to be painted at 8K-by-8K resolution — some even bigger — to emulate the look of actual satellite photographs. “There is an insane amount of detail in those images,” noted Greg Strause. “In the empty vacuum of space there is nothing to obscure the image — no fog, no dust, no atmospherics. The shadows are Pitch Black and the highlights are very bright. And, because the camera moves in these shots were very gentle and slow, we couldn’t hide a lack of detail with motion blur.” To achieve that level of detail and clarity, Hydraulx ran micro-displacement map renders in mental ray. “We had hand-painted texture maps and displacement maps with five or six million polygons. Using mental ray, we would render that with our subsurface scattering shader, so it looked like a thick, billowy, volumetric cloud — even though it was really a hard, polygonal, displaced object.” The volumetric quality of the supercell allowed for a slight parallax shift. “These cameras arc around the earth, and so you see a little bit of parallax on the clouds. That, along with the displacement maps and the subsurface scattering, really sold the sense of scale.”

Back on planet earth, bizarre storms begin to plague geographical locations around the globe. Production shot plates for a violent hailstorm in Tokyo — which drops volley-ball-sized chunks of ice on the city — on a street set constructed on stage in Montreal. Neil Corbould's crew sculpted real hailstones from 20 tons of ice; then, 50 effects technicians threw them from the stage grid as cameras rolled. "Doing it by hand was the most efficient way to produce this hailstorm," Corbould commented. "We rehearsed it time and time again so that every one of the 50 guys knew exactly when to drop his block of ice. Unlike a machine that would spit out the ice no matter what, real people throwing the hailstones could use their judgment and decide if it was too dangerous to throw them at a particular point because of the positions of the actors below."

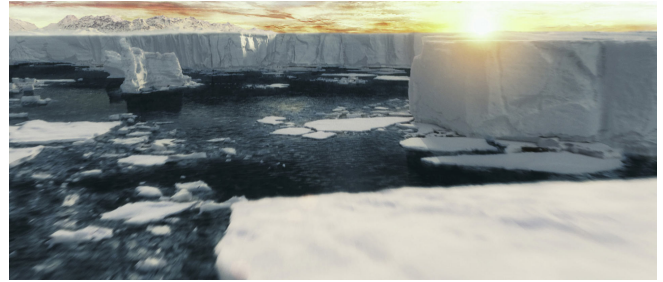
For hailstones that needed to fall onto or nearer live performers, Corbould provided harmless, lightweight simulations made of plastic.

"Unfortunately," recalled Goulekas, "the plastic hail had a tendency to bounce, which didn't look good at all. We realized we'd have to add CG hail to these scenes."

Hydraulx character animators substantially increased the minimal hail in the live-action plates — both real and plastic — by modeling 20 different ten-inch-diameter 3D hailstones and animating them through frame. Integrating the hailstones into the scene required an exhaustive rotoscoping effort.

"Production had dressed the set with hundreds of shattered ice pieces on the ground," explained Colin Strause, "and we had to roto all of them to place our CG hailstones in between them. There were also roto issues in making the hailstones go behind and between all the people running around. It was a roto nightmare." Making the task even more complex was the translucent, refractive qualities of the 3D hail. "We had to refract the plate through the 3D. We built a temp object that represented the scene and projected the actual footage onto that, so that the ice chunks would refract and bend the light."

Each of the 3D hailstones had to fall through frame, then shatter upon impact with the ground, cars, buildings or people. Hydraulx programmers built a collision system to simplify the animation of the shattering ice. "We prebuilt generic shattering hailstones and wrote expressions with little control curves or lines," explained Greg Strause. "An animator would load in the prebuilt shattering



The film opens with a three-minute flyover that reveals the oceans and icy topography of Antarctica, where climatologist Jack Hall (Dennis Quaid) and his crew are drilling ice cores for scientific examination. Hydraulx computer generated the entire shot, simulating the ocean water through shaders and scanning sculpted miniatures to generate geometry for the digital icebergs and ice shelf. Hydraulx laid in a CG mountainscape and a tiled photographic sky to extend the imagery into the horizon.



The opening shot ends on the climatologists' camp. Hydraulx hooked up its all-digital imagery to a live-action plate shot on a minimal stage set surrounded by bluescreen, enhancing it with additional CG structures, vehicles and characters. A custom scene-building program that only loaded objects visible in any given frame enabled Hydraulx to efficiently render the polygon-dense 4,000-frame flyover.

sequence, aim the line at the point where he wanted the piece to hit, and then adjust the size of the radius to determine how big of a splash the little pieces would make as the hailstone shattered. Animators popped in those scripted hailstones as filler for the background and midground — so they only had to hand-animate the hero hailstones close to camera.” Particle systems simulated explosions of more minute flakes of ice.

The hailstorm is just a precursor to the catastrophic weather anomalies to come, such as a maelstrom of twisters that cuts a swath of destruction through Los Angeles. Emmerich’s brief to Digital Domain, which created most of the sequence, was to make the tornadoes look real, rather than ‘Hollywood.’ “My philosophy,” explained Emmerich, “was that when we were creating natural phenomena that people are familiar with, ours had to look exactly like the real thing.” Toward that end, production provided Digital Domain and visual effects supervisor Matthew Butler with volumes of real tornado reference. “These days, everybody has a video camera; so there is an enormous amount of twister footage. One of the first things Karen did on the show was gather that real-life footage and cut it together.”

“I cut a ‘Twisters Greatest Hits’ tape that had about 120 real twisters in it,” recalled Goulekas, “each designated by a number. That became our guide. As we were doing different shots in the sequence, we could say: ‘This one should look like twister number 67; this one should look like twister 29,’ and so on. We didn’t want all the twisters to look the same. Roland wanted each of them to be a distinct character.”

Emmerich’s reality-grounded philosophy applied to the skies in the sequence, as well as the twisters. “Often,” Emmerich commented, “I watch movies, and the visual effects will be quite good — but the skies look totally painted. If the sky is real, it makes everything else look real. I thought, ‘Why not shoot real skies for the twister sequence?’ So I had Anna Foerster, my second unit director, go out and do some storm-chasing.” If not for a malfunctioning camera, Foerster would have caught an actual tornado on film when her storm-chasing landed her in proximity to the real thing. “When she came back, I said, ‘Anna, the twisters will be done in the computer — you only had to get the background!’ She got a lot of wonderful skies; but we mainly used four or five Vistavision plates that had just the right look.”



Dynamic images of tornadoes cutting a path of destruction through downtown Los Angeles were created by Digital Domain. The company integrated its digital twisters with aerial plates of the city, photographed by production visual effects supervisor Karen Goulekas from a helicopter. Sunny Los Angeles skies were replaced with dark, menacing ones shot by second unit director Anna Foerster during a bout of storm-chasing in the Midwest.

Prior to the production's move to Montreal, Emmerich filmed plates for the sequence in Los Angeles, accompanied by a Digital Domain crew that gathered tracking and lighting data. In the skies over Los Angeles, Goulekas supervised the shooting of plates from a helicopter — an assignment dogged by misfortune. "I ended up having to go up for 25 flights because there were so many problems," Goulekas recalled. "On the last day of shooting, I was up in the helicopter while Roland was on the ground with extras running around the Capitol Records building — our last shot. We had wrapped! We were going to a party at Roland's house that evening! But when we landed, I turned around and saw that there was 1,000 feet of film sitting on the parking lot — the takeup side of the magazine had jammed. So we had to shoot a clean plate, later, and add digital people. We had planned on adding some digital people to the extras anyway — but now, because we'd lost the footage with the extras, we had to add all digital people."

Digital Domain motion captured stuntmen and actors and used that data as the basis for panicking CG crowds. But the twisters themselves were the company's most significant contribution to the sequence. The gauntlet thrown down by Emmerich and enthusiastically picked up by the Digital Domain team was to make the twisters better and more photoreal than any seen in previous films. "All of the effects in this movie are things audiences have seen before," observed Butler, "but never at this level. There was a real push to make them all that much better, because we were redoing something that had been done very well in *Twister*. That was a daunting thing for myself, digital effects supervisor Bryan Grill and our teams, because the tornadoes in *Twister* were fantastic!"

To maintain a measure of control and art direction with the *Twisters*, Digital Domain opted against generating them through a physical dynamics simulation. "A *Twister* is a physical phenomenon made up of a volume of particulates," Butler commented. "I thought that if we could re-create the physics of this natural phenomenon, we would be halfway there. But our final approach involved an emulation of the phenomenon, rather than a simulation. A simulation is a highly accurate copy of physical dynamics; an emulation merely creates the look and feel of those physical dynamics. An emulation looks like a simulation, but without all the underlying, accurate mathematical structure."

Rendering *Twisters* that emulated those dynamics demanded a volumetric solution — specifically, Voxel-B, an in-house volumetric rendering tool that Digital Domain had used to great effect on previous projects. "Voxel-B hooks into Houdini," said Butler. "For this, we refined it so that we could actually resculpt the shape of the *Twister*. We would come up with the general shape of the *Twister*, then the dynamics of the *Twister*, and render it as a volumetric in Voxel-B." Effects artists also generated a debris field to surround the volumetric core of the *Twister*. "A *Twister* is a pressure field; and the only reason we can actually see it is because it has picked up dust and debris. We had to fly a ton of debris around and correlate it to the destruction of the buildings."



To maintain a measure of art direction and control, the DigitalDomain effects team opted to emulate tornado physics, rather than re-create them through a mathematically accurate dynamics simulation. Referencing a video compilation of more than 100 real tornadoes – cut together by Goulekas – Digital Domain developed a twister geometry and dynamics, then rendered them as volumetrics, surrounding the volumetric cores with particle system dust and debris.

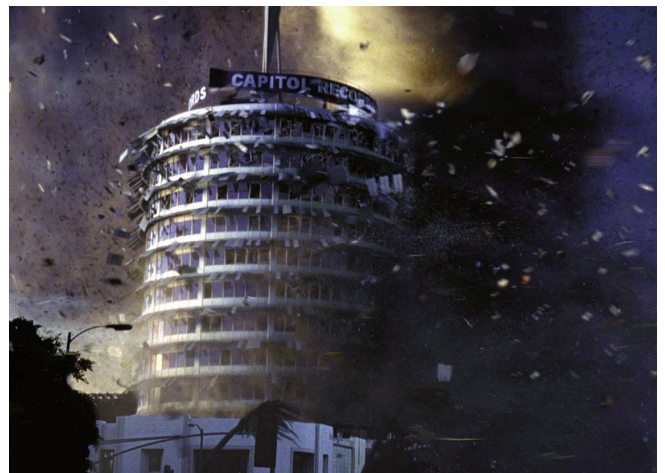
The *Twisters*' destruction of city structures necessitated building CG models, which originated from lidar scans of buildings in downtown Los Angeles and along Hollywood Boulevard and Vine Street. Mike Chambers oversaw the scanning effort, a smaller-scale version of a three-month lidar project he had organized in New York for the storm tide sequence. Scans in both cities were executed by LiDAR VFX president Paul Maurice. "We were asking for something that had never been done on such a grand scale before," noted Chambers. "In our early meetings with LiDAR VFX, I could see a hint of fear on their faces — but I could also see them champing at the bit to meet the challenge. The biggest challenge for me and my team was just getting the lidar crew onto the multitude of rooftops and other odd locations they needed to do their thing."

"The scale of this undertaking was unprecedented," added Paul Maurice, "both in scope and in the level of detail required. It pushed the envelope of available technology to such a degree that customized equipment had to be built to our specs, just to handle everything." Customized equipment included a new laser scan head, which had a range of three miles.

The lidar scans yielded extremely dense models of the L.A. structures, which Digital Domain modified and textured for the *Twister* sequence. New tools proceduralized *Twister* damage to the buildings. "We developed tools that determined the proximity of a *Twister* to any particular building," said Butler, "and, based on that, determined the likelihood and extent of the destruction." Like those of the *Twisters* themselves, the dynamics of building destruction were emulated rather than simulated, with artists creating varying levels of shake and collapse.

Because the *Twisters* had to appear to move in front of and behind buildings and physical landmarks, occlusion became a major compositing issue. "Typically, at the compositing stage of a shot, we're layering elements on top of each other," said Butler. "That works well in a multiple 2D world, where Object A is always seen in front of Object B. But when you have a volumetric like a *Twister*, that element is in front, inside and behind the object you are trying to composite it with." To get around the problem, Digital Domain software developers devised a z-depth compositing tool that told the compositor what proportion of the *Twister* element was in front of or behind another element. "The *Twister* element had information describing how far back it was in space, and whether or not it was occluded by another object."

The sequence begins with a single *Twister* forming in the Hollywood Hills, as seen from Griffith Observatory. As more *Twisters* form, television news crews chase them throughout the city. In a 360-degree Steadicam pan around newscaster Tommy Levinson (Tim Bagley), multiple *Twisters* surround the character and decimate nearby buildings. Other than live-action of the newscaster, his cameraman, a few extras and localized buildings, the panning shot had to be constructed entirely in post. "The plate lacked breaking buildings," Butler observed, "lacked *Twisters*, lacked debris, lacked all of the hundreds of CG elements that would eventually be in the shot."



A tornado decimates the iconic Capitol Records building in Los Angeles. For shots of building destruction, the Digital Domain crew modified and textured CG models built from

Everything had to be added. And, since there was no process screen, that meant a lot of rotoscoping. Every leaf on every tree in the foreground had to be roto-scoped — because it was against the real sky, which had to be replaced by the Vistavision sky. We had whole roto teams on that one shot for the better part of a year.”

lidar scans of real L.A. structures. Custom tools proceduralized the destruction by determining the extent of building damage according to the Twister’s proximity. To manage occlusion issues as Twisters moved behind, in front of and between buildings, Digital Domain wrote a z-depth compositing tool that kept track of the Twister’s position relative to other objects in frame.

Near the end of the sequence, a janitor inside a building — blissfully unaware of Mother Nature’s rampage outside — opens an office door, only to discover that the entire building has been sheared in half. “At that point,” explained Goulekas, “the camera does a long pullback to reveal the Twister dissipating in the distance and the path of destruction left in its wake.”

Hydraulx assembled the shot. “This 400-frame pullback helicopter move reveals the destruction of all of downtown L.A. and the outlying areas,” observed Colin Strause. “It starts with a plate of the janitor opening a freestanding door and doorframe, shot on a bluescreen stage. From there, it goes to Digital Domain’s passes of four or five destroyed building miniatures, shot greenscreen. The miniature looked really good, but it needed more life. So, we modeled massive CG facades that were alive with crumbling and smoking, mangled concrete, hanging beams, rebar with chunks of concrete swinging off of it, pieces of hand-animated debris drifting in the air — anything we could do to add movement to the miniature.”

Hydraulx created a digital landscape to extend the miniature as the camera continued to pull back. “We built 3D buildings by eye,” explained Greg Strause, “then projected a matte painting onto the 3D city, which gave us full parallax as the camera moved. In the background we added Digital Domain’s dissipating Twister element and a lot of particle debris.”

The massive supercell storm makes its way across the Northern Hemisphere, extracting frigid air from the upper regions of the atmosphere and drawing it downward, instantly freezing everything in its path. Production awarded supercell effects to *The Orphanage*. “I went into this project thinking that the Twisters and the storm tide would be the most difficult effects,” said Goulekas. “But for those effects, we at least had reference and knew what we were shooting for. The supercell shots turned out to be more difficult because, first, we had to figure out what they should look like.”

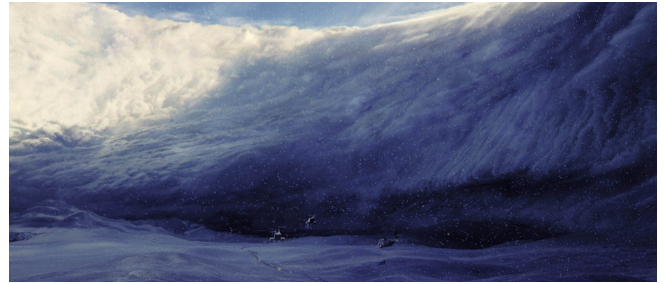
The look of the supercell continued to evolve throughout postproduction, and was ultimately conceived as a multilayered cloud formation alive with both internal and external movement. *The Orphanage* realized the supercell through techniques ranging from full volumetrics to 2½D solutions. “We tried several combinations of techniques to lead us to a photoreal look,” said *The Orphanage* visual effects supervisor Remo Balcells. “We ended up projecting an image of collaged clouds that had been created by our matte department onto a piece of torus-shaped geometry. We enhanced it with 3D volumetric cloud effects when it was close enough to camera that we needed to see detail and motion. For internal motion, most of the time we used a procedural approach, moving textures and offsetting the texture fractal noises.”

In another series of shots created by *The Orphanage*, three helicopters sent to rescue the British royal family fly into the center of the storm, then crash due to the freezing of their fuel lines and rotors. Karen Goulekas and the previz unit had generated animatics for the all-digital crash sequence, cutting together helicopter shots from *Black Hawk Down* as a starting point. Digital Domain refined that previz, creating shaded animation of helicopters crashing on land, which became the launching point for *The Orphanage*. “That animatic did not have any of the details or the snow flying out,” said Balcells. “The camera movements in it were approved, however, so it gave us a strong base to work from. We tweaked and adjusted the moves and added a round of secondary motion to both the cameras and the choppers to add a sense of reality to the scene. We also added textures and snow and all the beauty passes — everything to make it photoreal.”

One difficult aspect of the sequence was the absence of customary explosion or fire elements as the frozen helicopters — dropping like inert boulders — crashed into the snowscape. ‘Explosions’ of snow added some much needed dynamics to the shots. “The energy of the crash releases clouds of snow into the air,” explained Balcells. “We started with reference footage of snowboarders and skiers, as well as avalanches. To re-create that look, we developed volumetric snow clouds and powder through a particle system, using our own pipeline, Brazil and AfterBurner.”

The Orphanage animated three CG helicopters to crash, piloted by generic CG figures in shots that were close enough to make out vague human forms in the cockpits. The sequence ends when one surviving pilot crawls out of his crashed chopper and is instantly frozen in the sub-zero climate. Working with a practical plate in which an actor emerged from a downed helicopter set piece, *The Orphanage* created a CG frost effect on the live actor and also retimed his performance, as per Emmerich’s postproduction instructions. “We took one frame of the pilot’s face and body that was not motion-blurred and re-projected it onto 3D pilot geometry we had built from a Gentle Giant Studios cyberscan,” said Balcells. “Manipulating that underlying 3D geometry, we could frost up the face and re-time his motion a little bit. We were able to get away with that because the shot was a lockoff and the pilot wasn’t moving very much.”

The story cuts to New York, where Jack’s son, Sam (Jake Gyllenhaal), and his friends run to the upper levels of the New York Public Library to escape a surging storm tide that floods all of Manhattan. The physical effects crew achieved live-action shots of water filling a subway station and other on-set flooding gags. “We built a tank that was 40 feet



The supercell storm front traverses the United Kingdom, threatening a convoy of vehicles and helicopters attempting to deliver the royal family to safety. The Orphanage, which was awarded all earthbound views of the supercell, had to first develop the look of a phenomenon for which there was no real-world reference. To create the moving, multilayered cloud formation, The Orphanage projected collaged cloud imagery onto torus-shaped geometry and enhanced it with 3D volumetric effects to impart detail and motion.



square and 12 feet deep,” said Neil Corbould. “Then we built a subway station set on a platform and lowered it into the tank, to make it look as if the water level was rising.” The tank was also used for a scene in which the lower levels of the library fill with water as Sam makes a desperate phone call to his father. Again, Corbould positioned a library set on the platform, along with the camera and the actors, and lowered it into the tank. For flooding street scenes in front of the library, Corbould’s crew constructed a tank measuring 120 feet long by 80 feet wide and three feet deep along the length of a library exterior set.

The Orphanage also created all-digital shots of the rescue helicopters crashing into the snowscape as their rotors and fuel lines freeze in the storm’s frigid atmosphere. Starting with a shaded animatic from Digital Domain, The Orphanage team built and animated CG helicopters, and added camera movement, textures, lighting and the snowy terrain to achieve the desired photoreal results. Explosions of volumetric, particle system snowclouds added dynamics to the pyro-free crashes.

Corbould’s practical setups yielded close shots of ground-level flooding; but all of the medium and wide shots of the storm tide were achieved digitally — a situation that made for some sleepless nights for Roland Emmerich. “I was the most nervous about these water sequences,” Emmerich admitted. “Water is always difficult to deal with; but especially so in this film, because the water had to interact with buildings. We shot only the library street set and the water tank bluescreen; everything else had to be created.”

After briefly considering using miniatures for the storm tide shots, Emmerich opted to build a virtual city. “By building the city in the computer,” Emmerich said, “we could create the shots, change them as needed. If I wanted another angle, all we had to do was render the building from that angle. A CG city gave me much more freedom.” LiDAR built the CG Manhattan at film resolution from its scans of 15 city blocks. During the three-month scanning project, Digital Domain took 40,000 photographs of city buildings to gather textures that would subsequently be mapped onto the lidar geometry. Digital Domain then incorporated those models with CG water effects.

As with the *Twisters*, the water shots had to surpass those seen previously in groundbreaking films such as *Titanic* and *The Perfect Storm*. “There have been many advances in water in the past few years,” said Matthew Butler, “but we had to advance it to the next level for this movie. We had water pouring through the streets of New York City, interacting with people and cars and buildings. That meant we couldn’t use the kinds of cheats we’d done for *Titanic*, such as separating the ship from the water and disguising the integration of the two. For this, the water and buildings and people were all one and the same. We needed the capability of accurately computing the complex physics of water moving around objects.” To do that, Digital Domain rewrote its proprietary fluid simulation software to streamline it and make it less time intensive, an effort led by CG supervisor David Prescott. “We also worked out a system in which we handed off frames to different machines as a way to compute the behavior of the water — not the rendering of it, just the geometric basis of it. It could take a week for a machine to complete a simulation of water moving down a street, without the rendering.”

The continually changing topology of the water — churning with floating debris and whitewater — complicated the storm tide shots. “For a shot of a car spinning around and moving along with the water, for example,” said Butler, “we needed to know where in the geometry that car existed in one frame, where it existed in the next frame, and so on, in order to animate, texture and render it. We wrote a piece of code that would compute the secondary physics, the debris, the cusp of the water,

how much it bent back on itself to generate whitewater. We wrote tools to figure out where we had to create that whitewater.” Digital Domain artists then created the whitewater through a particle system and volumetric rendering in Voxel-B. “The whitewater was driven by the dynamics of the underlying wave, so that its behavior felt integrated. None of this had been tried before. Huge advancements were made in controlling the simulation and computing it so that we could have cars and debris bobbing through the water.”

To fill out live-action crowds that had been filmed on the street set, Digital Domain populated some shots with digital crowds running from the flood’s leading edge. Digital Domain first determined the different types of movements that would be needed in the CG characters, and then motion captured those behaviors. “We built up a library of behaviors,” stated Butler. “To get the look of people wading through three feet of water, we motion captured actors walking through boxes full of packing peanuts. Then we photographed wardrobe extras to give us different clothing textures. We were able to design many varieties of people by assigning different textures and behaviors to them. They were mass-produced and distributed to populate shots with thousands of people.”

Hydraulx used Digital Domain’s elements to assemble 11 of the final 13 ground-angle storm tide composites, adding reflections, mist, interactive light across the scene and painted elements to create a stormy, dark sky. To correct some on-stage lightning frames that had blown out white, Hydraulx animated lightning and created all-new frames from surrounding frames. Hydraulx also made significant aesthetic adjustments to better integrate the CG water against the CG or live-action set pieces.

Tweak Films contributed to all-digital aerial shots of the storm tide, including an initial reveal of the tidal surge overtaking the Statue of Liberty. Provided with a CG model of the statue and simulated water elements from Digital Domain, Tweak integrated additional elements, using its own fluid simulation and rendering tools, developed over the previous two years. “The first thing we did was construct the main swell of the wave by hand,” noted Tweak founder and visual effects supervisor Chris Horvath, “modeling it and animating it in Maya. To get the look of smaller waves traveling on that very large main swell, we used a tool that simulated wind-driven ocean waves, generating those ocean waves as height fields. We also wrote a tool in Maya that allowed us to apply those ocean waves to the hand-animated swell shape. It was similar to a displacement technique, but done with geometry instead of in the render.” Technical director Francisco De La Torre wrote shaders for the main ocean body.

Another simulation created the look of foam forming on the surface of the waves, then dissipating over a span of seconds. “We made a 10-million-particle foam simulation to create a foam that stayed on the surface and reacted to the actual sharpness of the crests in the ocean that we had generated,” explained Horvath. “We wrote a tool that analyzed the height of the ocean to figure out where the crests were and where this foam would be generated.”

One of the aesthetic concerns was maintaining scale in the simulated water, which Tweak ultimately determined by eye, finessing multiple iterations of waves. Scale was particularly an issue in the gigantic splash that is created when the storm tide impacts the Statue of Liberty. “The splash around the statue consists primarily of Digital Domain’s splash element,” said Horvath. “Then we blended a splash element that we created into the dark areas to add volume and body. Paint fixes

were made to the splash where it flies through the base of the statue.” Secondary mist blows off the main body of the splash. Tweak CG supervisor Jim Hourihan wrote a new external particle system to achieve the effect. “The challenge was to create the impression of strong winds, but still make the splash itself feel heavy and big. The rise and fall of the main splash is affected very little by the wind; but these lighter misty particles are affected very strongly by the wind and blow around violently.”

“This was a ‘kitchen sink’ shot,” remarked Goulekas, “with water elements created by both Tweak Films and Digital Domain. The final comp showcased the best water elements from both companies and made for a spectacular shot.”

The city appears at the end of the Statue of Liberty shot, a background tiled together from aerial photography supervised by Goulekas in a SpaceCam-equipped helicopter. Veteran matte painter Peter Lloyd sweetened the photographic cityscape with painted storm clouds and lightning. “Peter painted cloud detail on top of this very elaborate photograph of the city,” noted Horvath, “which we subsequently projected onto 3D elements to give us 3D movement, without going entirely CG. He also worked for two weeks on lightning, creating a separate light painting for every lightning hit.”

Tweak provided subsequent aerial views of water overtaking the southern tip of Manhattan, flooding the streets, and, finally, surrounding the New York Public Library where Sam and his friends run to take cover. “The shot shows the library from overhead,” observed Horvath, “as the kids are running towards it. The water splashes up against the front of the library, wraps around it, and continues on through the city. We were able to get an extremely high-resolution simulation of the water flowing around the library and interacting with all the buildings. The resolution of the simulation was much higher than I’ve ever run before. It is a minor numerical miracle that it didn’t blow up — because it should have.” Buildings in the shot were high-resolution lidar-based models built at Digital Domain. Tweak Films detailed the models with grime and other shader work to enhance their scale.

As the tide washes over the city, a freight cargo ship is carried along with the wave, coming to a stop in front of the library. Two underwater shots, revealing the underside of the ship crushing cars, utilized Digital Domain miniatures, shot in a tank. For later scenes within and around the ship — lodged in ice — production built partial full-scale sets on stage. All of the wide views of the ship navigating city streets made use of a CG freighter, built by Digital Domain and incorporated with lidar buildings, CG water and live-action elements of actors on sets, filled out with digital characters.



A surging storm tide floods Manhattan. Medium and wide storm tide shots were achieved digitally, requiring the interaction of simulated water with a CG New York. To build the virtual city, production orchestrated a three-month lidar effort, scanning 15 New York City blocks from a variety of angles. Digital Domain took thousands of photographs of city structures to obtain textures that would be mapped onto the lidar geometry. For several aerial views, Tweak Films incorporated its own CG water into previously rendered city elements, adding interactive splashes, surface foam and mist.

Later in the story, Sam and his friends search the freight ship for medical supplies, and are stalked through its corridors by a pack of wolves. Industrial Light & Magic executed approximately 30 character animation shots of the wolves as part of its overall 60-shot assignment for *The Day After Tomorrow*, supervised by Jim Mitchell and Eric Brevig.

Emmerich resorted to computer animation only after attempts to shoot the scenes with real animals failed. “We started off thinking we would not have to do CGI wolves,” said Goulekas,” and that we could get our shots — or most of them, at least — with real wolves. But when the animal trainer showed up on set with his wolves, they were these incredibly shy, docile creatures. They were so afraid of the people and the sounds and the lights and the cameras, we couldn’t get any performance out of the poor things. They also had some dog/wolf hybrids that they were training to run up and down the stairs of the ship; but their tails would be wagging as they ran down the stairs — how scary is that? After a couple of days working with real animals, Roland said, ‘We’re going to have to do something else.’”



The storm tide sweeps through city streets toward the New York Public Library, where Jack’s son, Sam (Jake Gyllenhaal), and his companions run to escape the rising flood waters. Provider of groundbreaking water effects for Titanic and other films, Digital Domain had to raise the bar for The Day After Tomorrow to create the illusion of digital water interacting with people, buildings, cars and floating debris. Digital Domain rewrote its proprietary fluid simulation software, making it more intuitive and efficient, to meet the needs of production.



Production captured live-action elements for the sequence on a partial exterior street set, built on stage in Montreal and surrounded by bluescreen to provide a matte area for CG water, set extensions and digital crowds. Digital

Domainmotion captured a variety of actions and photographed extras in different costumes to build up a library of behaviors and textures that could be applied to the digital characters. Hydraulx composited and finessed many of the street-level shots.

“The wolves were the worst prima donnas I’ve ever worked with!” Emmerich added. “It was like shooting with four Elizabeth Taylors on the set. It was a disaster. So, whenever I shot the wolves, I also shot an empty plate — just in case. Finally, we accepted that we’d made a mistake with the real wolves; and, at that point, we went looking for an effects house that could do computer generated wolves.”

With its extensive experience in creating 3D-animated characters, ILM was an obvious choice. From ILM’s standpoint, computer animating all of the wolf shots was a better situation than intercutting its CG wolves with the live-action wolves. Not only was matching not an issue, the all-CG approach enabled ILM to design wolves that looked exactly as Emmerich envisioned them. CG modeler George Aleco-Sima built a hairless wolf model that was only slightly bigger than the real thing, but allowed for behavior that was considerably more ferocious. “I asked Roland how far he wanted us to push the behavior of these animals,” commented animation director Dan Taylor. “His response was: ‘Have you seen my movies?’ We played around with some of their natural postures and behaviors and gave them a red-eye glow to make them look meaner. We did anything we could to up their fear factor.”

ILM modified the basic wolf model to produce four wolves of different sizes and coloration. To gather raw material for wolf animation, ILM motion captured trained German Shepherd police dogs. “We wanted to motion capture a really aggressive animal,” explained Taylor, “and we found that police SWAT dogs were perfect. They are accustomed to having gear on them, so they weren’t fazed when we put a spandex mocap suit and sensors all over them. And they would do anything we wanted. They’d go through walls, fly down stairs — everything production hadn’t been able to get the wolves to do.”

To determine action and composition, Taylor and lead animator Scott Wirtz produced an animatic of the entire wolf sequence. During mocap sessions, the ILM crew and trainers put the police dogs through all the actions indicated in the animatic, using stand-in sets to represent those in the live-action plates. To better simulate the icy ship environment in which the CG wolves would interact, the crew slicked up the floors of the mocap stage. “The dogs would run,” recalled Taylor, “and when



Physical effects supervisor Neil Corbould and his crew built a three-foot-deep tank along the entire length of the library exterior set to facilitate live water interaction with performers and vehicles. For close shots of flooding inside the library and in a subway station, Corbould built a platform that supported the sets, cameras and actors, then lowered it into a 12-foot-deep tank, creating the illusion of rising water levels.

they rounded corners, they would lose their footing and slip and slide — which added a whole new level of dynamics to the shots.”

Because the German Shepherds were smaller than the desired size of the wolves, ILM scaled down the sets on the mocap stage accordingly. The motion capture itself also had to be tweaked so that the actions of the dogs would work in the larger wolf model. Just as cameras are often overcranked when shooting miniatures to give them a sense of larger scale and weight, the motion capture system was set up to do 60 samples per second — the equivalent of 60 frames per second on a motion picture camera — with final sample rates decided on a shot by shot basis. “It was like doing a slow-motion trick,” said Taylor, “but in the motion capture realm.”

A newly developed blending tool was critical to achieving seamless animation from the motion capture of animals. “With human performers,” remarked Taylor, “you can tell them exactly what to do in any given motion capture setup — walk up the stairs, turn right, jump down. But with animals, you get what you get. We’d have a shot that required a specific set of actions, but we did not necessarily get those specific actions all in one take on the motion capture stage. So we’d break up the action into several different takes, then animators would use the blending tool to blend all the mocap data together and make it look like one smooth action. We keyframed things — especially the heads and ears — to push the performances even further.”

A dynamic simulation drove the animation of the tails. “There is more of a physical dynamic aspect to the movement of a tail than there is to a leg or another part of the body,” stated CG supervisor Chris Townsend. “So, after animating the wolf bodies, Scott Benza — one of our associate animation directors — passed the wolf through a dynamic simulation, which simulated the natural movement of the tail.”

Dynamic simulations also endowed wolf fur with life and movement. Technical directors covered the hairless wolf models in fur in the rendering stage, utilizing ILM’s revamped hair simulation engine. Wolf pelts shipped from Alaska provided hands-on reference. “We were able to look at the hair and really study it,” observed Townsend, “down to how the light played in the hair, the coloring over the length of the hair, how many hairs there were per inch. Because we had such great reference, and because we had a relatively few number of shots, we decided to say to *Hell* with efficiency and go for the very best look we could. We wound up with about seven million hairs on our wolves, which is considerably more than other hairy creatures we’ve done. It gave the fur a very dense, fluffy look.”

Light interaction with the fur was another key factor. Production’s unusable real-wolf footage provided ILM with impeccable lighting reference for its CG wolves, which aided their integration



The Orphanage enhanced the scale of its earlier supercelleffect and incorporated it with the virtual city for shots of the 50-mile-radius storm front engulfing Manhattan. The Orphanage also created the look of frost forming on city skyscrapers as the storm nears, using global illumination and radiosity techniques to make the digital geometry appear as photoreal as possible.

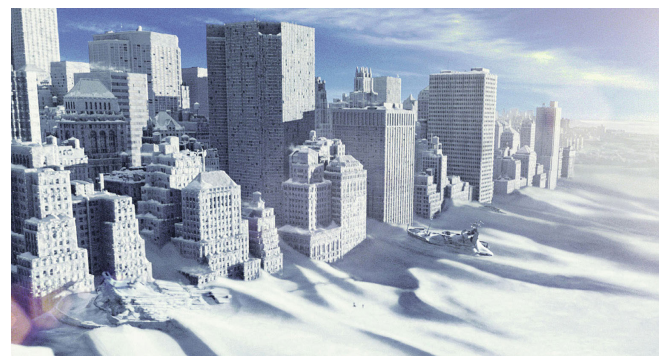
into clean background plates. ILM also generated interaction within the environment — knocking CG items off of tables as wolves passed and adding paw skid marks to the floors — to sell the illusion of the wolves’ on-set presence.

Compositing supervisor Mike Conte oversaw assembly of the wolf shots, including one from earlier in the film, set in the Central Park Zoo, where a change in animal behavior signals the shifting climate. The shot features four agitated, caged wolves, one of which lunges toward the cage door, at camera. “The plate we were given was just the camera dolly past an empty cage,” said Conte, “but the director wanted the cage door to rattle and to rack focus with the leaping wolf. To do that, we painted a still frame of the cage without the cage door, laid that still frame over re-created geometry of the cage, and animated the CG cage to bend and rattle as if the wolf was going crazy inside.” Compositors simulated the interaction of the CG wolf’s paws on the straw floor of the cage by displacing the straw and creating little pockets as the paw made contact.

Sam and his companions have no sooner escaped the wolves in the ship when they must outrun the approaching supercell storm — the ‘big freeze’ that instantly ices everything in its path. “The audience knows what is coming,” noted Karen Goulekas, “because they saw what happened to the pilot in the earlier helicopter crash scene. But this is even worse. Where that supercell had a ten-mile radius, this one has a 50-mile radius, with the eye over Manhattan.”

As they did for the smaller supercell, artists at *The Orphanage* created shots of the massive weather system over New York, as well as shots of frost forming on city buildings. For the frost effects, *The Orphanage* started with the digital New York cityscape. “We used global illumination and radiosity techniques to make the geometry look as photoreal as we could in the 3D world,” said Remo Balcells. “Once we had that, we passed it on to the matte painting department, where we re-projected that onto the geometry from the camera POV.”

Icy tendrils of frost seem to reach for the kids as they run through the halls of the library. Using boujou and lidar scans of the library interior sets, Hydraulx tracked all of the plates and added a procedurally-generated, fractal ice pattern to the walls and furniture. “Every feature of the ice growing in the scene had to be done in 3D,” said Greg Strause. “We had to model all the curtains and lamps and sofas on the set to get the ice to cover everything. We did matte passes in Maya, and then brought it into Inferno and ran some image-processing to give the ice a bumpy quality. We also darkened the plates — since the growing ice blocks out the light — and added CG particle breath on all the people to suggest the cold air.”



Industrial Light & Magic created later views of the city encased in ice, combining painted textures and 3D

procedural rendering techniques on 150 high-resolution lidar buildings in the mid- and foregrounds, and on additional low-resolution structures in the backgrounds. To simulate wide expanses of snow-covered ground, ILM crew members laid baking soda or talcum powder on a flat surface, then tapped it to create interesting crevices and cracks. Maintaining scale in the all-white buildings — devoid of scale-enhancing textures such as rust, watermarks and stonework anomalies — was a challenge in all of ILM's ice city shots. Photographs of the setup were used either as reference or as texture maps applied to the CG terrain. Subsurface scattering techniques gave the icy cityscape a translucent, photoreal look.

ILM produced approximately 30 subsequent shots of Manhattan shrouded in ice, springboarding off a frozen city shot that had been created by Dreamscape Imagery for an early teaser trailer. “Dreamscape got the previz and the lidar buildings,” explained Karen Goulekas, “then killed themselves getting the shot done in six weeks so it would make it into the teaser. They did a great job.”

ILM first re-created the teaser shot in concept paintings, then refined it to accommodate Emmerich’s vision of more arctic lighting and bizarre formations of rime ice — a striated, layered, directional ice — to add visual interest to the snow-covered, all-white skyscrapers. “We had to do tests to figure out how thick we could build up this ice before the scale fell apart and it started looking like some kind of surreal science fiction phenomenon,” said ILM visual effects art director Alex Laurant. “Some of the ways the snow and ice could build up between buildings were quite fantastic; but Roland thought that they were too distracting, visually. A more subdued, subtle version of the ice buildup was better suited to the sequence.”

While determining how far to push ice formations, ILM also grappled with the issue of scale on the snow-covered skyscrapers. “Because these buildings were covered in snow,” noted Laurant, “all of the cues that normally tell us about scale and distance — brick or stonework, aging, rust — were gone. So the problem was making the buildings look in scale and not as if they were miniatures or CG. We finally nailed it; but what at first blush seemed to be a fairly straightforward sequence turned out to be anything but. It was a difficult and challenging process of discovery for us and for Roland.”



The *Day After Tomorrow* ends with the sun peeking out from the clouds and helicopters arriving to rescue New Yorkers who have survived the storm. The signature shot of the sequence is a sweeping panoramic view. Featuring CG helicopters, CG survivors waving from skyscraper rooftops, foreground high-rez geometry, painted textures on background low-rez geometry, dust elements shot on stage and a real photographic sky, the ILM composite consisted of more than 300 layered elements.



The lidar-based CG city for the panoramic view at film’s end. The basic geometry was acquired by LiDAR VFX, which had used a new, customized laser scan head with a range of three miles to scan structures in New York City. That geometry was distributed to the various effects facilities working on specific city shots, each of which modified, textured and lit the digital cityscape as needed.

ILM accomplished the final ice city look by combining painted textures and 3D procedural rendering techniques on the 3D building geometry — 150 high-resolution lidar buildings in the mid- and foregrounds, and additional low-rez buildings in the backgrounds. ILM's model shop and digital matte departments created individual pieces of ice reference to guide the lighting in shots. To obtain reference for wide shots of the snow-covered ground, crew members laid baking soda or talcum powder on a large flat surface, then shook it to create interesting crevices and cracks. Photographs of the setup were used either strictly for reference or to provide texture maps. Strategically rendered bounce and keylight and subsurface scattering shaders gave the ice a natural, photoreal look.

The signature shot in the frozen city sequence, featured at the end, is a large panoramic view of the city as helicopters arrive to rescue survivors. "That shot had everything," said CG supervisor Gregor Lakner. "It had the buildings and CG helicopters and survivors. As the helicopters fly around the MetLife building, you see a very good portion of Manhattan, and portions of the Bronx and New Jersey. The database for all of that was enormous; so we tried, whenever possible, to only go with 3D in the stuff that was really close to camera. Whatever was further back was done with textures projected onto low-rez geometry."

ILM's proprietary crowd pipeline generated all of the survivors in the shot, waving from the rooftops and upper stories of the buildings. "Roland was very fond of saying that the shot was all about the people," recalled Mike Conte. "Because I'm a compositor, I was concerned about making the shot pretty, with a great sunset, lens flares, and spec highlights kicking on the backs of the buildings. But Roland never wanted that to distract from the people in the shot. He wanted to make sure you could clearly see them. We re-animated the people in clusters and had them run away from the helicopters as they landed. We did everything short of giving them big white flags to wave." Made up of simulated crowds, foreground high-rez geometry, painted textures on background low-rez geometry, dust elements shot on stage, and a real photographic sky, the composite, assembled by Jeff Doran, consisted of more than 300 layers.

Up until just weeks prior to the film's release, Emmerich was undecided as to whether it would end with the helicopter rescue or with a coda illustrating a more global emergence from the storm. "We wanted to give the ending a worldwide feeling," noted Emmerich, "and show the storm dissipating in Europe, with clouds clearing from around the top of the Eiffel Tower."

New Deal Studios built and photographed an Eiffel Tower miniature for the shot, which was composited by Hydraulx. "The model was 1/72-scale," stated New Deal visual effects supervisor Ian Hunter, "which brought it to 13 feet, 10 inches tall. My model crew chief, Aaron Haye, first built a CG version of the tower in Rhino. That

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Man Made Monsters

image

ARTICLE BY JODY DUNCAN

Universal Pictures built a studio on the success of its horror films of the 1930s and 1940s. Director Stephen Sommers built a reputation on the success of *The Mummy*, a modern retelling of the Universal original. There is symmetry, then, in Universal and Sommers joining to create *Van Helsing*, a film that arose out of the irresistible notion of re imagining the classic horror creatures from those Universal films — *Dracula*, the *Frankenstein* monster and the *Wolf Man* — and aligning them against the venerated vampire killer, Van Helsing.

Supporting horror characters such as Mr. Hyde — whose cinematic legacy sprang from the stages of Paramount and MGM, rather than Universal — and *Dracula*'s brides brought Van Helsing's creature count to nine and translated to 500 shots for Industrial Light & Magic, 350 of which involved hardcore character animation. The story's 19th-century Transylvania locales were beautifully and authentically represented by the castles and terrain of the Czech Republic, and by production designer Allan Cameron's full-size sets; but both were rendered all the more spectacular with matte paintings by Illusion Arts.

The Van Helsing of Bram Stoker's novel, *Dracula*, has been portrayed in any number of stage and screen adaptations. The Sommers film presents a younger, more virile Van Helsing (Hugh Jackman), a member of a secret religious order that seeks out and destroys evil in its many manifestations. His newest assignment, to vanquish Count *Dracula* before the vampire can unleash thousands more of his kind upon the world, pairs him with Anna Valerious (Kate Beckinsale), a warrior princess whose family has been hunting the count for nearly 500 years.

In the film's black-and-white opening — an homage to the original *Frankenstein* film — an angry mob storms the Transylvania castle of Dr. Victor Frankenstein as the grave-robbing scientist attempts to animate his creature. The scene cuts between a massive laboratory set built in Playa Vista and exteriors shot at a 14th-century castle near the production's base in Prague. "We shot these exteriors on a frozen hillside at three in the morning," recalled Ben Snow, who shared ILM visual effects supervisory duties with Scott Squires. "There were 300 extras carrying torches — and it was freezing. But, for any



Van Helsing — writer/director Stephen Sommers' homage to the Universal horror films of old — opens with a black-

horror fan, standing on a hillside with peasants storming a 14th-century castle was a dream come true!”

The establishing shot of the castle included a matte painting by Illusion Arts. Originally, the Illusion Arts crew — which included founder Syd Dutton, supervising matte painter Kelvin McIlwain, freelance painter Bob Scifo and 3D artist Andrew Tucker — had signed on to do only a few shots for Van Helsing; but

the shot count neared 100 as Stephen Sommers expanded his original vision. “Stephen makes his movies not only on stage and on location but also in postproduction,” noted Dutton. “On Van Helsing, he continued to come up with ideas all the way through post; and, as a result, we were given more and more shots. For the *Frankenstein* castle sequence, we were originally just going to add a matte-painted laboratory on top of the real castle production had shot. But, as he looked at the shots, Stephen said: ‘That’s just a castle. I need a huge castle.’ So we wound up extending that real castle substantially.” Illusion Arts ultimately generated multiple views of the castle and its surroundings, incorporating layers of lightning flashes into their matte paintings, timed to the lightning that had been provided by the physical effects department on location.

Inside the lab, *Dracula* (Richard Roxburgh) murders Victor *Frankenstein* (Samuel West), and is then knocked into a fireplace by the doctor’s grief-struck creature (Shuler Hensley). For shots of *Dracula* emerging with his head and body aflame, production shot plates of a stuntman on fire and, separately, shot Roxburgh walking out of the on-set fireplace. “In the composite,” Snow explained, “we tracked to the stuntman a CG *Dracula* head made of a burning layer, two layers of burnt flesh and, finally, a healing skin layer that transitioned to Roxburgh. We also grew his hair back using 3D hair, forming *Dracula*’s hairstyle as he walked out of the burning fireplace.”

Captive Audience Productions designed and executed the *Frankenstein* creature makeup, applied on set by Greg Cannom. The full-body creature design was sculpted on a lifecast of Hensley, then fabricated in foam latex and silicone, interlaced with hard-surface areas. The final makeup included leg pieces that extended the actor’s height to over seven feet tall, finger extensions, a bulked-out torso and full head appliances. “Our design philosophy was to use only what would have been available at the time *Frankenstein*’s monster was being constructed,” noted Captive Audience head Keith Vanderlaan. “Since there wasn’t the technology for skin grafts at that time, *Frankenstein* would have had to assemble his creature with rivets and brass fittings.” The concept led Captive Audience to incorporate mechanical-looking devices into the creature’s arm and glass plates to his head and chest. ILM enhanced the makeup in postproduction by tracking layers of 3D electricity elements — suggesting brain activity — to the glass area in the head. A 2D effect created the look of a mechanical heart beating within the creature’s chest.

In an Illusion Arts shot, *Dracula* — in demonic form as a *Hell Beast* — exits *Castle Frankenstein* and, joined by his vampire brides, gives chase as the *Frankenstein* creature seeks refuge in a nearby windmill. Sommers’ brief for the shot was that the forms of the vampires be abstracted, so as to avoid fully revealing the characters at this early point in the film. “It took us a long time to come up

and-whitesequences at Victor Frankenstein’s castle, where the fevered scientist brings his grotesque creature to life. The castle-dotted countryside of the Czech Republic and full-size sets built by production designer Allan Cameron served as live-action settings for the film; but establishing shots of many locales were created through digital matte paintings by Illusion Arts. For establishing shots of *Castle Frankenstein*, Illusion Arts painted multiple views of the stark edifice, incorporating a jagged mountain vista and lightning flashes into the shots.

with the look of that,” said Syd Dutton. “Andrew Tucker did variation after variation, developing a cloak of turbulence that obscured the characters, which were 3D figures animated in Maya.”

For the following scene at the windmill, production shot two full-size sets — a windmill base surrounded by peasants and an upper tower where the *Frankenstein* creature hides — extended with Illusion Arts matte paintings. In addition, ILM bridged the footage shot on the two full-scale sets with a 25-foot-tall miniature, which also served for wide shots of the windmill.

Ignited by the villager’s torches, the windmill goes up in flame and the tower floor gives way, depositing the monster into the burning interior. The shot closes with a downward view of a fireball bursting up the central shaft of the windmill, toward camera. ILM’s practical effects crew rigged the miniature floor to collapse by pulling it apart with chains, and also set up pyrotechnics for the shaft explosion. “We tested the explosion,” said Ben Snow, “and we tested the collapsing floor, separately — and everything looked good. But when we put the collapsing floor on top of the windmill to shoot the hero element, everything got a *Hell* of a lot hotter because the windmill shaft essentially acted as a chimney. The whole screen was full of fire, and we burnt three lights — and got a bad take. The model crew quickly redressed, and we were able to get the shot by shooting in parts that same night.” ILM first filmed the windmill interior with the gas-bomb explosion rising up the central shaft, then the collapsing floor against bluescreen. The final composite combined the elements, along with a bluescreen element of a wire-rigged Shuler Hensley falling, as if dropping through the collapsing floor.

A wide exterior shot provides a spectacular view of the windmill explosion. The effects crew plumbed the miniature with flammable materials and engineered a weak-knee gag, scoring through its main support struts and using hydraulics and chains to pull it down. The model shop surrounded the miniature with a re-creation of the snowy hillside location, dressing it with white sand and baking soda. The crew conducted multiple tests on the setup, basing the choreography of the collapse on an animatic, then shot the hero element. Once again, all did not go according to plan. “We set it on fire and fired the collapse,” Snow related, “but it only collapsed halfway because one of the weak-knees got caught up.” The effects crew, thinking quickly, rigged cables and pyro to execute a second collapse, which would be combined with the first through compositing. “We shot a pickup on the collapse, blowing it up even bigger and pulling the whole back of the windmill off — so it looked as if it was doing a second fall. In compositing, we combined the first part of the collapse with the second explosion and follow-up collapse.” In the foreground of the composite, ILM blended a plate of *Dracula* and his three brides jumping down from the windmill — a wire gag captured on the bluescreen stage — and additional CG debris, including a CG cog that flies up toward camera, then slams down in front of the vampires.

A year later in a nearby forest, Anna Valerious and her brother Velkan (Will Kemp) set an elaborate trap to capture and kill a werewolf. *The ‘Old Man Wolf’* — so named because of his transformation into an elderly man in a scene ultimately eliminated — was one of three werewolves featured in the film. ILM art director Christian Alzmann and a nine-member



team took a shotgun approach to the design of the werewolves and other creatures, producing more than 1,000 pieces of art. “We explored every idea we could think of for a werewolf,” Alzmann said. “We designed werewolves that were four-legged and looked like huge bulls. We designed werewolves that looked more like men. We showed Stephen Sommers the whole gamut of pencil drawings, and he leaned towards really big, two-legged designs. Once we got the general idea, it was a matter of producing more illustrations until he said, ‘That’s our guy.’”

In a nod to the fiery finale of the original Frankenstein, the creature seeks refuge from an angry mob of villagers in a vacant windmill. Production built and photographed a full-size windmill base on a hillside outside Prague, surrounding it with many extras carrying torches. For a wide shot of the peasants approaching the structure, Industrial Light & Magic – which created 500 shots for the movie – composited a windmill miniature into a live plate.

In addition to the basic werewolf — best represented by the *Old Man Wolf* — the art department had to create distinctive designs for a Velkan werewolf and a Van Helsing werewolf, both of which would be revealed later in the film. “The original art we produced showed three very different-looking wolves,” Alzmann recalled, “but we had to simplify them later so we could use the same basic geometry for all three. We had to make the bodies similar, to keep the costs down — but we could dress those bodies differently, with different coloring and fur styles and heads.” In their final forms, the Velkan wolf looked the wildest and most beast-like, while the Van Helsing wolf was endowed with some of the physical attributes of Hugh Jackman. “Stephen wanted him to be this shiny, black, beautiful, sexy wolf. ‘Rock star’ was the term he threw out quite often. So we designed him with a mane of very long, flowing black hair.”

High-rez still photography of real wolves — brought to ILM by a nearby wolf rescue group — informed the modeling of the werewolves. The crew’s closeup study of the animals also influenced the werewolf animation style. Achieved entirely through keyframing, werewolf animation detoured from the real-life reference, suggesting a creature that was both bipedal and quadrupedal. “The werewolves are neither human nor animals,” animation director Daniel Jeannette noted, “but Stephen Sommers wanted to retain a little of both. So we devised a hybrid type of walk and run, with the werewolves running on twos most of the time, and on fours when needed. We drew our inspiration from the movements of bears and gorillas — powerful, big animals that can be both bipedal and quadrupedal.”

A primary consideration in modeling and animating the Velkan and Van Helsing wolves was their on-camera transformation from human to wolf — an effect that involved transitioning from live actor to a CG double to the CG werewolf. “From a modeling, rigging and texturing point of view,” creature supervisor Tim McLaughlin said, “everything we did was directed toward these transformations.” To facilitate the transformations, model supervisor Andrew Cawrse proposed building CG actor and werewolf models with the same number of control vertices. “The surface geometry of the werewolf model had corresponding points with the surface geometry on the human model; so when the character transformed from one form to the other, it did so in an organic way. That required meticulous model work, going back and forth between the human and the werewolf models.” ILM utilized its proprietary modeling tools, Caricature and Iscupt, to construct the human and werewolf geometries, working from scans of actors in pre-transformation poses and scans of werewolf maquettes sculpted in similar poses.

During filming, the ILM crew brought video cameras to the set and recorded the actors' performances from multiple vantage points to acquire information that would allow for three-dimensional transformations. "Back at ILM," said Jeannette, "we scanned and matchmoved footage from every camera. We also produced software in house, called Poseur, to do previz and match-animation. It allowed us to match-animate to the multiple cameras — usually three. We would use the motion picture camera, and put the character in one frame, and then correlate his position from the different perspectives of the other cameras — so we knew his position in space, and we knew what his body was doing from all different angles. That gave us a very accurate translation of what the actor was doing in 3D. Using that information, we could transform from the live actor to a 3D version of the actor to the werewolf."

To avoid a too-smooth, morph-like look, Sommers and ILM designed the transformations as physical events in which the human characters would rip their skin apart, revealing the werewolf beneath. An extensive R&D effort — CG supervisor Craig Hammack working with a team of 12 software specialists — resulted in proprietary tools that provided a realistic skin-ripping effect, and also allowed for modifications at any point along the creature pipeline. "In the past," explained Tim McLaughlin, "whenever we had to do something that ripped — for instance, the sock ripping as Bruce Banner transformed into *The Hulk* — we preplanned where each cut would happen in the geometry, and we did all of our modeling and enveloping and viewpainting based upon those pre-cut areas. In this situation, we didn't want to restrict ourselves by doing those pre-cuts. We wanted to let the ripping action evolve in postproduction, and allow Stephen to alter it as he saw fit. To do that, we needed a surface that could be ripped at any point. Essentially, our R&D department came up with a cloth simulation that could be rendered as flesh."

The Velkan and Van Helsing werewolves are seen in reverse transformations, as well, changing from werewolf back to human form. The disparity in size between the actors and the seven-foot-tall



The creature and his creator are trapped inside when the villagers set the windmill ablaze. The ILM physical effects team plumbed the miniature with flammable materials and used hydraulics and chains to pull down prescored sections during the structure's fiery collapse.



Built by the ILM modelshop and erected on a shooting stage, the 25-foot-tall miniature was surrounded with white sand and baking soda to replicate the snowy hillside location of the live-action shoot.

werewolves presented the problem of making the wolf collapse in on itself — but in a dynamic manner. “Going from human to wolf,” noted McLaughlin, “there is great tension in the skin because the character is getting bigger — which helps drive the rip. But in the reverse transformation, there is not that tension, because the model is shrinking in size. To help that, we made the transformation look painful, as if bones were popping out of joints because the creature’s physical structure was changing. We used shapes that abstracted the form and pulled in the skin.”

ILM upgraded its fur simulator to allow for closeups on the werewolves. Prior to this, ILM had created fur by simulating thin strips of cloth, then rendering those strips as hair. Van Helsing would require so much CG hair work — not only for the werewolves, but for *Dracula’s* brides — that an all-new fur and hair simulation engine had to be created. “It allowed us to simulate extremely dense fur,” stated McLaughlin. “The wolves had 8,000 modeled guide hairs on them, and those were rendered out to thousands of hairs, interpolated between the guide hairs.” Viewpainting, led by Jean-Claude Langer and Jean Bolte, established fur coloring. “We’d learned from our real wolf reference that there is a color change down the length of the hair, and that there are thicker guard hairs spread throughout the rest of the dense hair, which give it a particularly wild look. The density of the fur changes, as well — the fur on the chest is less dense than the fur on the back.” CG supervisors Carl Frederick and Curt Miyashiro spent many weeks perfecting fur shaders to cover the range of styles and environments in which the werewolves would be seen.

All of ILM’s new technology and artistry came into play early in the forest sequence, with a closeup of the Old Man werewolf eyeing Velkan tied to a post, acting as bait. As the wolf charges the post, Velkan does a flip backwards and is pulled up by a rope, the werewolf leaping and snapping at him from below as he slams into the pole, then falls into a hole camouflaged with a mesh of leaves. In the next shot, a metal cage rips out of the ground, suspended on ropes, with the werewolf imprisoned inside.

At forest locations outside Prague, physical effects supervisor Garry Elmendorf and his team provided interactive effects, vibrating the pole as if with the impact of the werewolf and simulating the creature’s fall by dropping a silhouette onto a leaf-covered tarp over a 15-by-15-foot hole. Three cranes positioned around the site hoisted the cage out of the pit. “We got the shots of the cage coming up out of the ground,” noted Elmendorf, “with the werewolf supposedly trapped inside. We had this giant Czech wrestler going crazy inside the cage to give us the interaction of the werewolf.” ILM created additional interaction in postproduction, digitally moving forest branches to suggest the werewolf’s movement in the foliage and adding claw marks to the pole.



Early in the film, one of the first shots of the werewolf, Valerious (Kelsey Grammer), is shown in a close-up, looking down at his hand. He is holding a small, dark, and somewhat translucent object, which is a small, dark, and somewhat translucent object. He is looking down at it with a serious expression. The lighting is dramatic, with strong highlights and deep shadows. The background is dark and out of focus.

When the cables holding the cage snap, the enclosure falls to the ground and releases the beast. ILM's model group rebuilt the top of the live-action cage for the shots. "We see the werewolf pop his head out of the hole," said Scott Squires, "and then he grabs the bars and literally rips the thing open. All of that was done by painting out the real top of the cage and replacing it with computer graphics." The sequence ends with Velkan tackling the werewolf, both of them going over a cliff, presumably to their deaths.

Illusion Arts augmented a location plate with painted scenery at the bottom of the cliff for a down-angle view. "We created the whole view of the gorge," Syd Dutton said, "with water at the bottom of it, slightly animated to give it some movement." Illusion Arts also replaced sunny skies with dark overcast skies throughout the sequence, and matched fog in the location plates that had been simulated by the physical effects team.

The story moves to Paris, where Van Helsing hunts the notorious Mr. Hyde — another classic horror character derived from literature and reimagined in any number of film, television and stage productions. Whereas all previous interpretations of Hyde had been realized only through makeup and acting skill, Stephen Sommers proposed that this one be an all-digital 'Super-Hyde.' Initially, Universal balked at the idea. "The studio was not sure it was going to be worth the trouble to do Hyde in CG," remarked Ben Snow. "Stephen told us that if we were going to do a CG character, he would have to be really, really cool. One of the keys to that, and the rationale for doing it as a CG character, was to make him very agile. Stephen came up with a lot of dynamic stunts for him to do, and his physical ability to do those things had to be incorporated into his design."

ILM's creature design team started with the screenplay description of Hyde as a huge, disfigured man. "We knew this would be hard to do," said Christian Alzmann, "because it is always hard to



Gabriel Van Helsing (Hugh Jackman) – on orders from the Vatican to vanquish evil in all its manifestations – confronts the notorious Mr. Hyde in the bell tower of Notre Dame. Realized through makeups in previous films, the Hyde character in Van Helsing was conceived as an all-CG, supernaturally agile, nine-foot-tall 'Super-Hyde.' To ground the CG character's performance and interaction with Jackman, ILM motion-captured Frankenstein creature actor Shuler Hensley in real time as he performed Hyde's scenes with Van Helsing, then integrated the resultant mocap-based animation into plates of Jackman acting alone.

create a CG human. But we figured that the more disfigured he was, the more we moved the design away from the look of a normal man, the more leeway we would have in the CG.” The designers gave Hyde an enormous head and a nine-foot-tall body that was muscular in some areas and flabby in others, with large feet, short legs, a curved spine, and arms that reached down to his knees. The diseased and disfigured look extended to Hyde’s skin, textures for which were derived from high-resolution stills of real skin, detailed with broken capillaries, veins, stretch marks, scars and hair. Software developers John Walker and Christophe Hery devised skin materials that featured a refinement of ILM’s subsurface scattering shaders to complete the look.

A scan of a Hyde maquette provided the basis for the CG model. “After that,” said McLaughlin, “all our efforts went into building the library of facial shapes we would need to create the performance. Performance was everything, because this character had to have a real one-on-one dialogue with Van Helsing.”

The dialogue, the complexity of the character, the number of closeups and the need for tight interaction with Hugh Jackman all contributed to the decision to base Hyde’s animation on a human performance. “As soon as we got the design,” recalled Daniel Jeannette, “we strongly recommended that they cast an actor for the voice so that we could record that before we shot anything. They cast *Robbie* Coltrane for the voice; and that gave us a very strong foundation for the performance. The voice was a huge part of this character.”

Coltrane recorded an initial voice track, and that — along with previsualization of the Hyde sequence by Rpin Suwannath — guided the shooting of plates on a massive set representing parts of the cathedral of Notre Dame, the setting for Van Helsing’s confrontation with Hyde. To ground Hyde in the scenes, *Frankenstein* creature actor Shuler Hensley portrayed the character on set. “Shuler had performed brilliantly in that big *Frankenstein* makeup,” said Ben Snow, “proving that he had a lot of physical agility; and so, we asked him to play Mr. Hyde. We put a Hyde helmet on his head, so that Hugh Jackman would have an eyeline guide.” Hensley and Jackman performed each scene together, initially; then Hensley stepped out and Jackman performed the scene alone, resulting in a clean plate into which ILM would insert its CG Hyde.

To provide ILM animators with a basis for the Hyde animation, Hensley’s performance was motion-captured on stage, in real time. “We did real-time motion capture on *The Mummy Returns*,” remarked Jeannette. “This time, I felt even more strongly that we should use that technology, because the shots were very dynamic, with the camera moving all the time. In my experience, if you shoot wild, you have to go in and tamper with the motion capture so much afterwards, you water down the original performance.” Back at ILM, lead animator Tim Harrington created rough animations, which Jeannette took with him when he flew to London to video-record final ADR sessions with *Robbie* Coltrane. “The animation gave *Robbie* a lot to work with and added a new dimension to his performance. And that video recording of the ADR session became the core material for the animators when they did all the lip-sync and facial work.”

“Since the animators always had reference of *Robbie*’s performance,” added Tim McLaughlin, “the character was never off-model. We didn’t have the problem of each animator coming up with his own idea of Hyde. *Robbie*’s videotaped performance drove that character.”

Model supervisor Frank Gravatt modeled a library of facial expressions and phonemes based on the video reference of Coltrane. Caricature keyframe animation delivered lip-sync and facial performance, while flesh dynamics provided another layer of organic movement. “Hyde does a lot of very active movements,” McLaughlin noted, “and because he is so massive, we needed the flesh to echo his primary animation with some jiggling and so forth.” The flesh engine — which also smoothed out textures across the body and corrected enveloping anomalies — was ‘full-flesh,’ meaning that it produced a volume of geometry, rather than a flat, 2D thing. “It is like a beach ball filled with goo — if you tugged on a section of the beach ball, you would see a reaction over its entire volume. Hyde’s body was a volume of flesh that was driven by his actions and movement.”

Illusion Arts established the Paris setting for the confrontation between Hyde and Van Helsing in a matte painting, and created CG sets — 3D geometry mapped with painted textures — for subsequent shots. “We built a whole 3D environment,” noted Syd Dutton, “the look of which was based on a vintage Paris postcard.” One of the initial Illusion Arts shots has Van Helsing discovering the body of a dead woman — Hyde’s latest victim — on Paris’ cobblestone streets. Jackman and the murder victim had been shot on a town square in Prague; but the location was deemed unsatisfactory. “We rotoscoped those two figures out of the live-action plate, and surrounded them in our 3D and 2½D world.” Illusion Arts also realized the next shot, in which Van Helsing spots the figure of Hyde — very small in the distance — climbing up the walls of Notre Dame.

Subsequent shots in the sequence featured a synthetic cityscape cyclorama created at ILM, using stills that Ben Snow had photographed in Paris. “We rejigged Paris a bit,” stated Snow, “moving the Eiffel Tower and taking the whole city back to the turn of the century. Digimatte lead Brett Northcutt used stills I’d taken of Notre Dame to create sets in the digimatte department.” Among the Notre Dame environments was the belfry where Hyde and Van Helsing first meet face to face — a partial set extended digitally. As their confrontation heats up, Hyde throws Van Helsing off the top of the cathedral. Van Helsing then shoots a grappling hook into Hyde and is rocketed up the front of the structure when the deranged character falls over the other side. The shots combined CG set extensions with live and bluescreen elements of Hugh Jackman on wires.

Hyde smashes into a CG version of the cathedral’s Rose Window, then transforms back into his alter ego, Dr. Jekyll, as he falls to his death. Dr. Jekyll was portrayed by a Prague local who — unfortunately for the ILM creature crew — looked nothing at all like Mr. Hyde. “We’d designed Hyde with some very clear characteristics,” said Ben Snow, “such as a widow’s peak and black hair. But the Jekyll they cast looked nothing like that! He was an older guy with gray hair, and his hairline was completely different. So the transformation from Hyde to Jekyll was a bit awkward. The idea we came up with was that Jekyll becomes a younger person when he transforms into Hyde.” Another problem in the transformation was that Hyde was considerably larger than Jekyll, requiring meticulous frame-by-frame shape animation to collapse the larger form into the smaller one. “It was almost like old stop-motion replacement animation. Frank Gravatt did that, and also came up with the idea of Hyde’s evil soul coming to the fore after he dies. He grows into this grotesque, hellish creature before settling back into the Jekyll character.” Lead compositor Sean Mackenzie used Elastic Reality to complete the transition to the live-action actor.

Yet another complicating factor was that the transformation occurs as Hyde falls from the top of Notre Dame. Production had built a tower top set surrounded with bluescreen to shoot Hyde's initial topple over the structure. ILM filled in the bluescreen area with a digital matte painting that synthesized the Prague live-action with the stills of Paris. The virtual camera dove down into this simulated environment, following Hyde's fall. "Since we needed to take some time to show the transformation and show him dying," explained Snow, "we extended and exaggerated the height of Notre Dame to give us a longer fall."

His mission in Paris accomplished, Van Helsing returns to the Vatican. The Vatican approach had Van Helsing on horseback — the only live element in the shot — surrounded by an Illusion Arts environment made up of a matte painting and a foreground miniature of statuary figures atop a colonnade. Illusion Arts also provided an interior view for a subsequent shot inside St. Peter's Cathedral. "The real interior of St. Peter's is huge," said Dutton, "but Stephen Sommers wanted this to be even bigger. In many old paintings of the cathedral, artists exaggerated its size — painting very small figures within this vast space — to capture the emotional experience of being there. Kelvin McIlwain did the same thing in this shot." The dynamic, moving camera shot was made up of the synthesized environment, live-action footage of Van Helsing, and bluescreen elements of Illusion Arts staff costumed as monks.

Van Helsing's assignment — to track down and kill Count *Dracula* — leads him and his friar sidekick, Carl (David Wenham), to Transylvania and the village of Vaseria, where Anna and other denizens live in the shadow of the vampire. Allan Cameron built a massive, full-size village set outside Prague, surrounded in part by an Illusion Arts mountain-and-sky cyclorama. Illusion Arts also matte-painted outlying areas of the village for wide shots, and provided shots of the sun disappearing and then emerging from clouds — important story points pertaining to the vampires' ability to attack.

Shortly after Van Helsing's arrival, *Dracula's* brides launch an aerial assault on Vaseria. On the village set, a Cablecam system captured swooping aerial plates into which ILM's brides would be composited. "Cablecam had two huge cranes at each end of the village," Scott Squires explained, "holding up a structure between them that had a motorized cart. The camera was suspended on that, and could move up and down. That was to get camera shots flying with the brides, or acting as their POV."

The physical effects department created interaction on the village set, such as pyrotechnic implosions and explosions on breakaway rooftops to suggest brides bursting into or out of buildings. Elemendorf's crew also added to the general mayhem on set. "We had debris coming out of air cannons," said Elemendorf, "and people falling into breakaway tables. All of this had to be tied with stunt people being pulled 20 to 30 feet into the air, as if the brides were picking them up and flying with them." In many shots, ILM transitioned from a practical stunt to a digital double after the initial liftoff.

The brides are revealed in both their human forms — played by Elena Anaya, Josie Maran and Silvia Colloca — and as vampire brides, for which the actresses wore a makeup designed by Greg Cannom and Captive Audience. "The vampire bride makeup was very subtle," said Keith Vanderlaan, "made

up of contact lenses, teeth and a few facial appliances. We didn't want to go over the top with a real vampire makeup. These brides were supposed to be beautiful, sexy and enticing, despite their monstrous look."



Victorious in his battle with Hyde, Van Helsing returns to the Vatican. Illusion Arts created a matte painting for a moving camera shot inside St. Peter's Cathedral, exaggerating the edifice's true size to capture the humility-inducing ambience of its hallowed interior. Illusion Arts composited the painting with footage of Hugh Jackman walking the length of a patterned floor – filmed against bluescreen – and added bluescreen elements of staff members attired as monks into the background.



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On orders to kill Count Dracula (Richard Roxburgh), Van Helsing travels to the Transylvanian village of Vaseria, which is dominated by Manor Valerious, Anna's ancestral home. Allan Cameron built an entire village set outside Prague, later extended, in shots rising above roof-lines, with a mountain-and-sky cyclorama rendered by Illusion Arts. An establishing reveal of Vaseria featured all-painted elements by Illusion Arts.



Soon after Van Helsing's arrival, Vaseria comes under aerial attack by Dracula's vampire brides. ILM effects crews developed a hybrid approach to creating the brides that enabled them to retain live actresses' facial performances while realizing distinctly inhuman, flying vampire bodies in CG. In a postproduction bluescreen shoot, ILM filmed the actresses in full vampire-bride makeup, wearing blue bodysuits dotted with infrared LED motion capture sensors. The motion capture data became the basis for 3D animation that, when tracked to the bluescreen elements, tied in perfectly with the movement and attitude of the live-action heads.

ILM which would create bride bodies in CG — as well as all-CG brides for distant shots — refined the makeup design to better tie in with its bride concepts. Bride features included elongated fingers, clawed feet, veining, and an emaciated, yet muscular physique. The brides' vague, PG-friendly nudity required that the gowns worn by the actresses be incorporated into their design, to ease transformations from woman to vampire bride. "The problem of getting rid of these clothes really drove the design of the brides," remarked Christian Alzmann. "We decided that the sleeves of the gowns would form the vampire wings; but that meant that there couldn't be any bones in the wings — as there are in a normal bat wing — because it would look weird to have bones coming out of soft, flowing clothing. Daniel Jeannette and Scott Squires came up with the idea of manta ray wings, which are muscular, but are made up of only tissue. Stephen liked that concept; and the rest of the design was drawn from that." Portions of the costuming that were not drawn up into the wings were digitally 'shrink-wrapped' onto the brides' pale bodies.

Transformations began with the distending of the actresses' jaws and the appearance of fangs — realized as a 2D or 3D effect, depending on camera angle and movement. "We modeled a CG jaw," said Scott Squires "and animated it to distend, rendering it and tracking it to match to the real jaw. As their jaws distend, they also turn white. That meant we had to rotoscope all of their jewelry and everything, then add vein texturing and so forth. We also had to do very tight match-animation of their heads and bodies to do the transformations."

The fantastical design of the vampire brides and their dynamic aerial attack choreography had mandated a CG approach — but Sommers also wanted to retain the performances of the real actresses in closeups. "We knew we couldn't do a full CG face for closeups of the brides," Daniel Jeannette said. "It is very hard to do a photorealistic CG face that stands alone in a movie and looks



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completely real against live-action. Also, even though their faces are more stylized as the brides, they still had to look like the actresses who played them in their human form.”

Scott Squires suggested a hybrid approach, in which ILM would track bluescreen elements of the actresses’ heads to CG bodies — thereby taking advantage of the photorealism of the real actress photography, while also taking advantage of the freedom of movement and stylization that could be attained with a computer animated character. “I presented that idea to Stephen,” said Squires, “and he liked the concept of having the actresses actually delivering their lines — but also being able to make use of CG, as necessary. We put together a test with somebody here at ILM, just to prove the concept. There was still doubt in some people’s minds, but once we started including hybrid shots, it became apparent that it was a worthwhile thing to do.”

Squires downloaded previz by Rpin Suwannath onto a laptop, and used that on set to guide the shooting of the background plates. Later, when Sommers and editor/ producer Bob Ducsay cut scenes together, ILM scanned the cuts, did matchmoves, and roughed out bride animation for specific shots. Precomps of that bride animation within the cut background plates served as templates for the bluescreen shoot, during which ILM filmed the bride actresses wearing full vampire makeup and neck-to-toe blue bodysuits. “It was critical that we have the timings worked out before we shot the bluescreen for any particular shot,” said Squires, “and also that we use the right type lens for each shot. We worked out all of that first; and so, when it came time to shoot the bluescreen, we knew exactly what the actress needed to do for each shot. The precomps allowed everyone to see our animated bride within the background and understand what she was supposed to be doing in the scene.”

The precomps also helped to determine which shots could sustain a full-CG bride — sufficiently distant shots, or those in which the bride moved very quickly past camera — and which would require a hybrid bride. “The brides flying in the distance are all CG, keyframe animation,” observed Daniel Jeannette. “Some in the midground are CG brides,

motion capture sensors. The motion capture data became the basis for 3D animation that, when tracked to the bluescreen elements, tied in perfectly with the movement and attitude of the live-action heads that enabled them to retain live actresses’ facial performances while realizing distinctly inhuman, flying vampire bodies in CG. In a postproduction bluescreen shoot, ILM filmed the actresses in full vampire-bride makeup, wearing blue bodysuits dotted with infrared LED motion capture sensors. The motion capture data became the basis for 3D animation that, when tracked to the bluescreen elements, tied in perfectly with the movement and attitude of the live-action heads.



but with a face replacement. The full closeup shots — about 45 of them — were done with the hybrid technique.”

Rather than just shoot the actresses’ heads against bluescreen and track those heads to the CG bodies, ILM motion-captured the actresses as they performed on the bluescreen stage. “There was no way we could just shoot a bluescreen head by itself, track it to a CG body, and make it look like it related to that body and the environment,” Jeannette explained. “So, we shot motion capture while filming the faces on the bluescreen stage. Motion capturing the actresses’ performances gave us a basis for body animation that would tie in to what their heads were doing. Because the face element was shot at the same time as the motion capture, the face and body locked together, and the perspective changes and body rotation lined up perfectly. If something in the motion capture wasn’t quite right, we could still go in and adjust it through keyframe animation.” The brides’ legs and their undulating wings were keyframe-animated throughout.

Because conventional motion capture systems do not work well under bright stage lights, ILM dotted the bluescreen bodysuits with infrared LEDs, which were bright enough for the motion capture cameras to detect under the lighting conditions of the bluescreen brides shoot. The resulting motion capture data was input into the CG bride model. ILM modelers created a basic geometry for all three bride bodies, then modified that generic model to reflect each actress’ individual physique.

The all-CG brides seen in distant or fast-paced shots freed the digital artists from the chore of shooting separate bluescreen heads, but presented the challenge of simulating the actresses’ flowing hair. The updated hair pipeline that had generated the werewolves’ dense fur also allowed for the simulation of the brides’ long hair. “To give us more control over the brides’ hair,” explained Scott Squires, “the simulation people put in tacks and other types of controls. In a lot of cases we had to match into live-action hair, which made control that much more critical.”

The unholy progeny of *Dracula* and his brides are pygmy bats, first revealed bursting from pods inside *Castle Frankenstein*. ILM designers gleaned pygmy bat concepts from script descriptions and their prior knowledge of Stephen Sommers’ aesthetic. “We had an idea, from the characters in *Mummy Returns*, what Stephen meant when he said the word ‘pygmy,’” Christian Alzmann remarked. “We knew he wanted something very nervous and jittery and small.” The final design was a white-colored bat with baby features, such as large eyes and a head that was too big in proportion to the rest of the body. The baby concept carried over into the creature’s animation, which included uncoordinated moves, as if



The effects-packed finale is set in *Castle Dracula*. Live-action for the sequence was shot on partial set pieces surrounded by bluescreen. ILM extended those partial sets using CG set pieces and photographic elements of a castle miniature. Illusion Arts matte-painted extensions in some shots, and also created the establishing shot of the castle. On stage at ILM, modelmaker Grant Imahara details the *Castle Dracula* miniature. / Facing off against Van Helsing, *Dracula* fully reveals himself as the Hell Beast, a large, demonic creature with dragon wings and razor-like teeth. Creature designer Carlos Huante sculpts the Hell Beast maquette.

the pygmy bats are just learning how to fly. In later scenes, the failure of *Dracula*'s animation experiments results in swarms of pygmy bats exploding into a mass of black goo — an effect achieved with particle-based procedural animation. “One of the tricks to the design was making the bats repulsive enough that you wouldn’t feel sorry for them when they blew up. They couldn’t be too cute.” Late in postproduction, Sommers instructed ILM to darken the bats so that they would not resemble seagulls in long shots.

The bats attack the village in a feeding frenzy, spurred on by the brides. As in the earlier bride attack, the stunt and physical effects departments facilitated live-action shots of flying pygmy bats picking up villagers and tossing them into the air, rigging an overhead grid on the set to launch extras aloft. In post, ILM match-animated to the extras and timed pygmy bat animation to make it look as if the creatures were grabbing and lifting the villagers off the ground. Close shots of pygmy bat action were hero-animated, while background swarms were created through a flocking program.

Having failed to bring his ‘children’ to life for more than a few minutes, *Dracula* determines that the *Frankenstein* creature is the key to the animation process. Traveling by horse-drawn coach, Van Helsing and Anna — attempting to deliver the *Frankenstein* creature to the safety of the Vatican — come under attack by the brides and the Velkan werewolf. Digital doubles of all the main characters, modeled from cyberscans of the actors, performed the most dynamic stunts in the coach chase and throughout the film.

The coach sequence, in particular, presented the problem of making the digital doubles look believable even as they performed outlandish stunts — such as Van Helsing leaping from galloping horse to galloping horse after being knocked off the coach by a bride. In order to ground the stunt in reality, ILM motion-captured a circus performer on wires, jumping from one horse silhouette to another, and utilized that motion capture data as the basis for its Van Helsing digital double animation. In another series of shots, Van Helsing executes a 360-degree somersault and lands between the horses — a CG Van Helsing that transitions to the live-action Van Helsing at the point at which he lands. For a shot in which a bride flies up with Van Helsing in her grasp, ILM employed a technique that was similar to that used for the hybrid brides — lead animator Steve Nichols pre-animated the action, which subsequently guided a bluescreen shoot of Hugh Jackman on stunt rigs. That bluescreen element was then tracked to the CG vampire bride’s leg.

The attack intensifies as the coach rushes toward a collapsed bridge over a deep gorge. Production shot the horse-drawn coach approaching camera. ILM blended that live-action with a CG bridge model and a view of the gorge below, created by the matte department. The action transitions to an all-digital shot — CG coach, CG horses, CG environments and digital doubles for all the characters — as the coach leaps over the gorge. Frank Gravatt led the modeling of the CG horses, working off reference photographs of the real animals used on location. “There were six horses with very different proportions,” said



Van Helsing attempts to free the Frankenstein creature from *Dracula*'s animation experiment in the castle laboratory. Greg Cannom and a crew from CaptiveAudience Productions designed and applied the full-body creaturemakeup, sculpted on a lifecast of Shuler

Jeannette, “and we had to match all of them by retrofitting a single model.” The animation of the horses presented the same problem as the Van Helsing stunts — making the impossible look possible. “The horses had to make this incredible jump over the gorge. Fortunately, the jump happens in slow-motion, which gave us a bit of latitude with the animation.”

Hensley, then fabricated in foam latex and silicone. Leg extensions rendered the actor more than seven feet tall. Cannom incorporated rivets and brass fittings into the makeup – making them appear to join areas of the creature’s patched-together body – to suggest crude 19th-century surgical procedures.

In mid-leap, the brides swoop down and land on the coach, holding it aloft over the gorge. Production shot a suspended coach against bluescreen, with the intention that ILM would combine the bluescreen element with CG environments and hybrid brides. “We wanted the brides to be able to really interact with the coach,” said Squires, “so when we photographed the hybrid brides, we had them land on a blue-painted coach on our stage. Then we replaced that blue coach with our CG coach. That gave us much better interaction than we could have achieved with the bluescreen coach element.”

Anna is captured by the brides during the chase; but after a trade of the princess for the *Frankenstein* creature, she, Van Helsing and Carl return to Manor Valerious to search for the portal into *Dracula*’s realm — discovered in a mirror hidden behind a map of Transylvania. The first gag in the sequence has the map transforming into the antiqued mirror. “On set, we dollied around Anna, Van Helsing and Carl standing in front of the map,” observed Ben Snow. “Then we removed the map and shot it again, with them standing in front of a mirror. Finally, we shot a pass with the mirror by itself. In post, we shoehorned those pieces together, along with a CG frost effect. *Dracula*’s world is very icy and cold, and we thought the door into his world should reflect that. So frost forms on all the mountains and lakes on the map first, and then eats the map away to reveal the mirrored surface behind it.”

Van Helsing puts his hand through the mirror; and when he retrieves it, the appendage is covered in ice. On set, Jackman inserted his hand into a hole that had been cut in the mirror surface. “Hugh reached his hand up to the mirror,” said Snow, “which gave us the reflection of the hand. Then, when the hand contacted the mirror, he pushed against the cut-out disk, and a grip holding it on the other side let the disk move into the mirror, so Hugh’s hand could disappear.” The CG frost effect helped to sell the physical gag. “We rotoscoped frost around his hand, and also used frost to conceal the edges of the hole, which was circular and not a perfect match to Hugh’s hand.” Van Helsing then steps through the mirror, an effect achieved via a larger-scale version of the hand setup. “We built a doorway in the mirror and, as Hugh walked up to the mirror’s surface, the grip behind the mirror pulled back the doorway so he could go through it. We used our CG frost to blend around his body and make it look as if he was actually penetrating the surface.”

Castle *Dracula* is the setting for the movie’s fast-paced finale, in which Van Helsing and his cohorts clash with Team *Dracula*. Early in preproduction, Deak Ferrand of Hatch had produced concept paintings of the castle, which informed its final design. Allan Cameron’s full-scale sets included a section of bridge over a moat and a partial foyer inside the castle, both constructed on enormous stages and surrounded with bluescreen. To fill out the partial sets, backgrounds had to be synthesized for 150 bluescreen shots in the sequence.

Foot-tall maquettes sculpted by ILM refined the castle designs and helped clarify the sequence's complicated choreography. "We used them to talk with Stephen about what was happening during all this bluescreen," said Snow, "to determine who would be where and what would be going on." After several rounds of design modification by Sommers, Cameron and Syd Dutton, the ILM model shop — under lead model builder Michael Lynch — constructed a 1/100-scale, 17-foot-tall miniature to create castle environments not covered in the full-size sets. ILM also built 1/20-scale sections for closer shots within specific castle towers. Director of miniature photography Marty Rosenberg shot the miniatures.

Castle *Dracula* is first revealed in an Illusion Arts matte painting. For subsequent views, Illusion Arts matte-painted extensions to the full-size sets, which were also augmented at ILM with miniature photography, CG set pieces and a mountainscape cyclorama. "There were mountains in almost every shot," commented Snow. "We'd developed CG terrain for Episodes I and II of *Star Wars*, and we adapted those techniques for creating these CG mountains." U.S. Geological Survey data provided the raw material for the synthesized mountains, which were based on the Grand Tetons in Wyoming.

Mountainscapes were incorporated with synthetic skies. "Stephen loves the old cloud-tank skies from movies such as *Close Encounters of the Third Kind*," stated Snow. "Scott Squires actually did the cloud tank skies for that movie, coincidentally. But, because our shots had big, flying camera moves, we knew that we wouldn't be able to shoot cloud tank elements. So we decided to develop a CG sky that would reproduce that look, while still allowing us to get all our 3D camera moves." New simulations and volumetric mental ray shaders ultimately re-created the look. "It was a very expensive, elaborate simulation; so we'd make a hero sky, and then make tiled backgrounds that compositors could just stick in behind shots. The skies and jagged mountains really helped to establish *Dracula's* world as a stormy, nasty environment." To tie together the disparate castle exterior elements and add atmospherics to the shots, compositing supervisor Marshall Krasser devised a method in which cards were mapped with 2D cloud textures, then layered in 3D space using ILM's Zeno software.

Interiors, as well, were realized through a combination of full-size sets, matte paintings and CG set extensions. Early in the sequence, Anna, Van Helsing and Carl explore the castle interior, discovering hundreds of pygmy bat cocoons lining the corridors. Illusion Arts contributed a matte painting to extend the full-size foyer set, which had been dressed with cocoons, into infinity. ILM duplicated that matte painting in a CG set for shots of the pygmy bats bursting to life and flying through the castle halls.

The *Frankenstein* creature escapes from the castle laboratory, only to find himself clinging to a tower above a 2,000-foot-deep gorge — an Illusion Arts matte painting — before slipping and falling. A stunt double for Shuler Hensley had been shot sliding down a partial tower set piece, falling into a blue pad. The shot transitions from the stunt double to the CG *Frankenstein* monster in mid-fall. The creature then grabs a series of cables, swinging down toward the bridge where Carl and Igor (Kevin O'Connor) are squaring off. "*Frankenstein* essentially becomes *Spider-Man*!" Snow quipped. "The digital-double *Frankenstein* did all the swinging moves — and then, when he lands on the bridge, that was Shuler Hensley."

Inside Castle *Dracula*, Van Helsing — bitten by the Velkan wolf during the coach chase — transforms into a werewolf. One of the specific challenges of the Van Helsing transformation was that, occurring so late in the film, the audience had already seen a number of werewolf transformations. “The problem was how to do this one differently,” Snow said. “This transformation also couldn’t take up too much time; because at this point in the movie, we had to move the plot along very quickly.” Serendipity helped to develop a unique look for the transformation. “We were working on the timing of the sequence, and had arranged our Van Helsing digital double with fur on it before doing the 3D shape-change into the wolf — and Stephen loved that. He said, ‘It’s the classic Wolf Man!’ That transformation became an homage to the *Wolf Man* movies of the 1940s.” To illuminate the jet-black Van Helsing wolf and make him read within the very dark Castle *Dracula* interiors, ILM cheated in rim lights, edge lights, and added arcing electricity and spark elements, augmenting those produced practically on the live-action set.

In a final to-the-death battle between the Van Helsing werewolf and *Dracula*, the vampire transforms into a *Hell Beast*. ILM’s art department produced a flurry of *Hell Beast* drawings, narrowing concepts down to a Carlos Huante design that featured huge dragon wings and a mouth filled with razor-sharp teeth. Modelers built the CG *Hell Beast* to facilitate transformations to and from *Dracula* in his human form. Lead animator Miguel Fuertes oversaw keyframe animation for the *Hell Beast*’s performance throughout the fight scene.

The werewolf kills *Dracula* in mid-transformation between vampire and *Hell Beast*. The creative challenge for ILM was to create a unique death scene for a character that had been killed off in countless films. “Our favorite *Dracula* death was from *Horror of Dracula*,” remarked Snow, “one of the first Hammer *Dracula* movies. In that one, he rots away to a skeleton and then collapses — and we wanted to take off on that. All the evil inside of him wells up and spews out of his mouth in a kind of goo; and then he rots away into a shriveled combination of the *Hell Beast* and *Dracula* — which was done with shapes and paint animation — until, finally, he’s only a skeleton. At the end, the skeleton slithers onto the floor at the feet of the Van Helsing werewolf.”

Anna injects the werewolf with a serum that will cure Van Helsing — but not before the wolf kills her. Sommers had conceived a poignant moment in which the werewolf transforms into a grieving Van Helsing, cradling Anna in his arms — a shot that did not lend itself to the established violent, painful-looking wolf-to-human transformation. “This transformation, unlike the others, couldn’t be horrific and grotesque,” explained Snow. “We had to do something that would return the wolf to Van Helsing, but retain the romance of the moment.” The solution involved the werewolf’s fur falling out as the creature transformed into Van Helsing. “It was a peaceful transformation that ended on a shot of Van Helsing standing naked, with Anna in his arms.”

The poignant ending to the Castle *Dracula* sequence, and an equally poignant denouement — created by Weta Digital — in which Van Helsing is visited by the spirits of Anna and her ancestors, were rare quiet moments in a film characterized by Stephen Sommers’ over-the-top style. That style infused every effects shot in the movie, every dramatic moment, every character, every environment. “Matte painting is so often all about making something look real,” commented Syd Dutton. “But, working with Stephen Sommers, it was about making it big — bigger, better and more

bold. And that gave us permission to let our imaginations run wild. Never once did Stephen say to us, ‘I think you’ve gone too far.’ It was always, ‘That looks great — make it bigger!’”

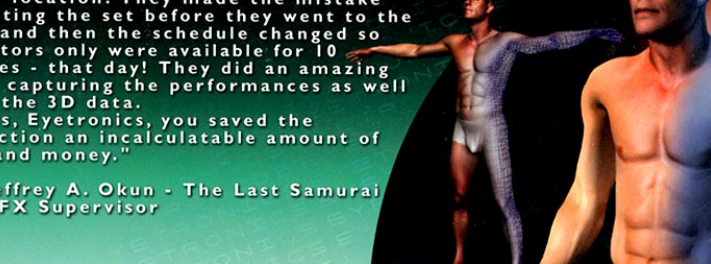
Boldness and size characterized ILM's work, as well, particularly its creation of a veritable Who's Who of Horror. "We did 500 shots for this show," commented visual effects producer Gretchen Libby, "but within those 500 shots was an incredible scope and variety of work. *The Hulk* had featured approximately the same number of shots; but that project had required mastering the look and animation of only one character. They were able to set up a pipeline for that one creature and start banging out shots. Van Helsing had so many creatures, we had to have multiple pipelines. We had to work out design issues, modeling issues, animation and rendering issues over and over again, starting basically from scratch with each new creature. It was a big, big challenge."

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"I was amazed at how flexible, fast and accurate the Eyetronics team was! The Eyetronics folks flew for 36 hours to get to our location. They made the mistake of visiting the set before they went to the hotel and then the schedule changed so the actors only were available for 10 minutes - that day! They did an amazing job of capturing the performances as well as all the 3D data. Thanks, Eyetronics, you saved the production an incalculatable amount of time and money."

Jeffrey A. Okun - The Last Samurai
VFX Supervisor

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